Industrial QUALITY CONTROL

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In This Issue

Attaining Uniformity in Processing Rubber Batches

—P. E. GNAEDINGER

The Role of a Biometrician in the Pharmaceutical Industry

—C. I. BLISS

Perception, Preference, Judgment - Clues to Food Quality

—DAVID R. PERYAM & RUTH SHAPIRO

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(Continued on page 37)

Industrial Quality Control

Vol. XI **APRIL, 1955** **No. 7**

Table of Contents

Registration Form 1

ARTICLES

Attaining Uniformity in Processing Rubber Batches
P. E. Gnaedinger 5

The Role of a Biometrician in the Pharmaceutical Industry
C. I. Bliss 10

Perception, Preference, Judgment—Clues to Food Quality
David R. Peryam & Ruth Shapiro 15

DEPARTMENTS

What's New?
Roy Wylie, Editor 3

Ninth Annual Convention Program 20-21

Bibliography
Joseph Movshin, Editor 23

Local Section News 26

Classified Ads 40

Consulting Services 40

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Attaining Uniformity in Processing Rubber Batches

P. E. Gnaedinger

Dominion Rubber Company Ltd.

INTRODUCTION

The attainment of uniformity in batch processing can be assisted by the use of operator control charts. In fact it is doubtful if best results can be attained without them. The influence that they may have is largely dependent upon the philosophy that guides their administration. There are four aspects that will be considered under this head. First is the concept that a so-called batch process should be treated as a continuous process. Second is the predominant importance of the human element in process control. Third is the conviction that the majority of workers are inherently interested in doing a good job. Fourth is that it pays to expend effort to make process control data easy to interpret. These four points will be discussed in this paper against a background of rubber batch processing through the stages outlined below.

The processing begins with masticating the crude rubbers to bring them to a consistency suitable for the subsequent stages of processing. The next step is weighing out the various chemicals and rubbers into batch lots prescribed by the various formulas. In the next stage the materials are combined together in rubber mixing mills to form a homogeneous mass that is slabbed out and cooled ready for calendering, extruding or other conversion processes. The compound weighing and mixing operations comprise the batch processing part of the rubber manufacturing process. They are the heart of the process. How well they are done determines in large measure the quality of the finished product that issues from the other end of the plant.

The important variables are weight, time, and temperature. Sometimes some of the weighing is mechanically controlled, and sometimes the mixing time cycles, but generally the important factors are under the direct control of the workers.

Quality is gaged by taking a sample of each completed batch and subjecting it to various qualification tests before it is released for further processing. Some of the tests are indirect in that they do not evaluate the characteristics that are of concern. This is an inherent difficulty in control and exists because of the very nature of rubber.

Thus, there are two good reasons for applying control chart techniques to rubber mixing, first the reliance that must be placed on the human factor in the process and second, the uncertainty that surrounds the test data. There is also a third reason that bears considerable weight—it is better to know that processing is being done right while it is being done, rather than wait until the work has been competed before trying to find out if it has been done correctly. The third reason grows in stature in the light of the second, for the means of detecting potential trouble in subsequent processing is certainly not too good with compounded rubber stocks. The penalties from lack of control can be severe.

BATCH OR CONTINUOUS PROCESS

The mixing of rubber stocks is called a batch process because the raw rubbers and chemicals are weighed out in batches and combined together in batch lots. This processing method usually leads to thinking of the process in a batch-by-batch sense. That is, each batch is treated as a separate lot without any relation to those that have gone before, nor to those yet to come. Each batch that is tested is judged upon its own merits. It stands or falls as an individual. Actually the chief reason why batch production prevails is because of physical limitations of the equipment. If the stock could be mixed continuously, it would be.

The fact that the material goes through the process in batches should not prevent us from thinking of the process as being continuous. Each series of similar batches is produced, or is expected to be produced under the same system of conditions. The equipment should operate consistently, the men should follow standard procedures, and the material should come from a homogeneous source. Under these conditions, the output should be homogeneous although produced intermittently. And under this concept each batch becomes a sample from a continuous run. Results from each test sample should be viewed, not as isolated tests, but more in their relation to preceding tests. The information conveyed by each test is

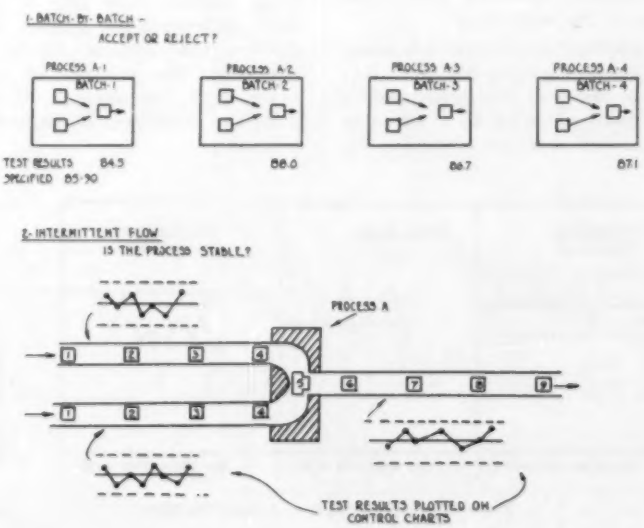

Figure 1

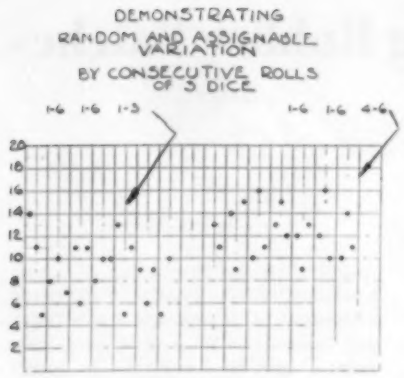

Figure 2

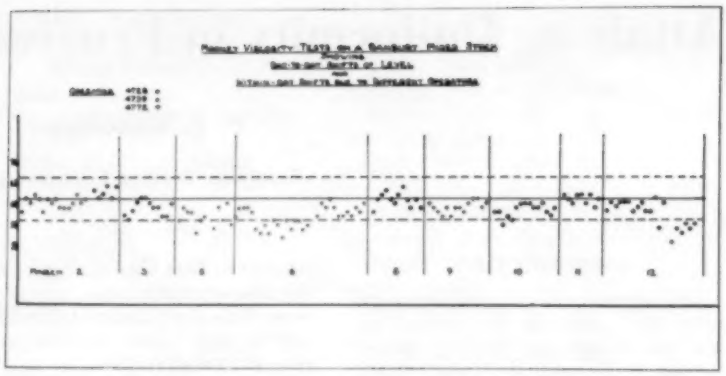

Figure 3

supported by the accumulated knowledge of the process as built up by experience.

Figure 1 illustrates the difference between the two concepts. This is a simplified case where two materials are being combined in a process to form a third material. In Fig. 1-1 each batch is judged on the basis of its individual test with respect to the specified quality. Each batch stands upon its own merits. In Fig. 1-2, the successive batches are pictured as being fed in an intermittent stream to the process, and leaving it in the same way. Control charts present the test data. By this means the chart establishes a pattern of the variation to be expected from batch to batch. Often the variation can be attributed largely to the error of sampling and test procedure.

With this technique each test becomes an indicator of whether the material is continuing to be about the same as in the past or whether something has happened that makes it significantly different from other batches of the same type.

The implications behind this manner of judging quality are quite different to the ones that arise when a test is used more as an attempt to pin an exact measure of quality on a specific lot of material. If the batches are treated as individuals the attention is on each batch, the prime consideration being what to do with it if it is off-standard. But when production is treated as a continuous stream, attention is focused on the process and its variables. Emphasis is shifted. The aim becomes to prevent the variables from getting out of control.

The distinction between the two concepts is perhaps subtle but it makes a great difference in the long range results obtained. When attention is directed to the variables in the process, it will not be long before steps are taken to keep the variables under control. That is where true quality control begins to develop. For 'control' implies the *prevention* of trouble, or detecting it in the early stages before much damage can be done.

There is a by-product of such quality assurance. When it is known that process variables are under close control, it is safe to predict with confidence the quality of production yet unmade. Under these conditions the number of samples taken and the amount of testing done can sometimes be reduced considerably.

THE HUMAN ELEMENT

At this point it seems appropriate to make a reference to the hackneyed elements of variability—men, machines and materials. The reason is to demonstrate just how these elements *do* affect variability. For this purpose three dice can be used, two numbered in the conventional way 1-6 and the third 1-3. Each die represents one of the elements; men, material or equipment. Now if these dice are rolled a number of times and the total points plotted in sequence on a chart to a suitable scale, the resulting pattern will be typical of product quality variations. These arise from the variations caused by interaction of the three elements of variation; men, machines and materials.

Next, change the die numbered 1-3 to one numbered 4-6 and assume this represents either a change of operator, or a machine adjustment, or a new lot of material. In other words, a change has been introduced to one of the variables of the process, say for example, a different operator is now working on the job. Next make a new series of rolls with these dice and plot on the chart as a continuation of the previous series. Figure 2 is a sample

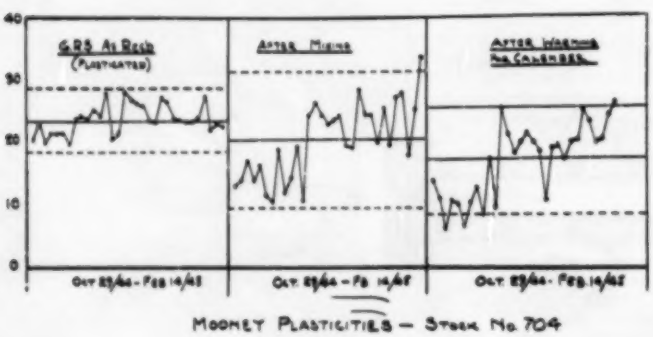

Figure 4

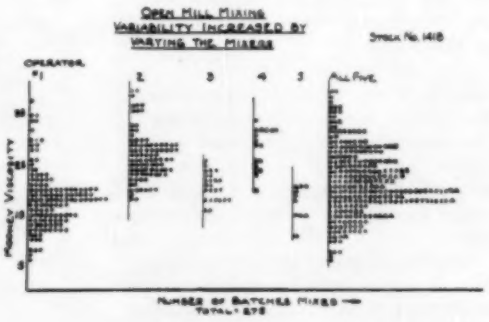

Figure 5

of how the two series would look. Both series exhibit similar variability, but there has been a shift of the average quality level.

Such shifts take place in actual practice as demonstrated in Fig. 3. In this case changes in quality level from day to day were detected by the control chart and traced to changes of operator. The way to improve uniformity, quickly became obvious; it involved training each of the operators to work in a standardized way and then establishing controls to see that they did. Before studies of this kind were started, it had been customary to accept such variability as being inevitable just because rubber is highly variable as received in its raw state.

While it is true that men, machines and material are the broad bases for classification of process variables, we must be careful to blame the right base when trouble arises. For example, in the case of Fig. 3 the man who uses the stock might attribute his troubles to the variability of the material he is using. In a sense he would be right, but basically his material would be more uniform if the men who mix it in the first place would all follow the same techniques.

Fig. 4 illustrates the same point. In this case the control chart for the raw material as received showed normal variation in quality. However after it had passed through the mixing operation, a shift of level appeared at the thirteenth test and the same shift persisted through the next stage of the process. An analysis of this kind emphasizes the fact that often our processing troubles stem from the things we do or don't do to the materials after they have started through process, rather than from the materials themselves.

Most of these errors of commission and omission can be traced to the unpredictable human behavior. For example if some unsuitable material gets into process, should we blame the material or rather the man who accepted or released it? If a machine has produced off-standard material, should we blame the machine or the man who operated it or perhaps authorized its use?

Candid answers to questions of this kind will probably lead to the conclusion that the predominant cause of variability is really the men in the plant. Generally speaking, the quality variations introduced by the operators consciously or otherwise are much more difficult to foretell than those arising from the materials or equipment. From this, it is apparent that the control of workmanship is usually the key problem in quality control. These observations are not made as a criticism of the man as an operator, but only to localize the problem.

PRIDE OF WORKMANSHIP

The way to get consistent, good workmanship from a group of people starts with a genuine conviction that most workers have a natural desire to do things well. With this as a foundation the next thing is to find effective ways to encourage each one to do his best. The first essential is to systematically evaluate the quality of each man's work, and second to make his rating a personal matter with him.

Unfortunately our industrial system does not work that way. One of its handicaps lies in the fact that relatively few of the individuals engaged in making a product ever see it when it is finished unless they happen to buy it for their own use. Certainly there are a great many of them who never see the direct result on the finished product if they deviate from specified instructions.

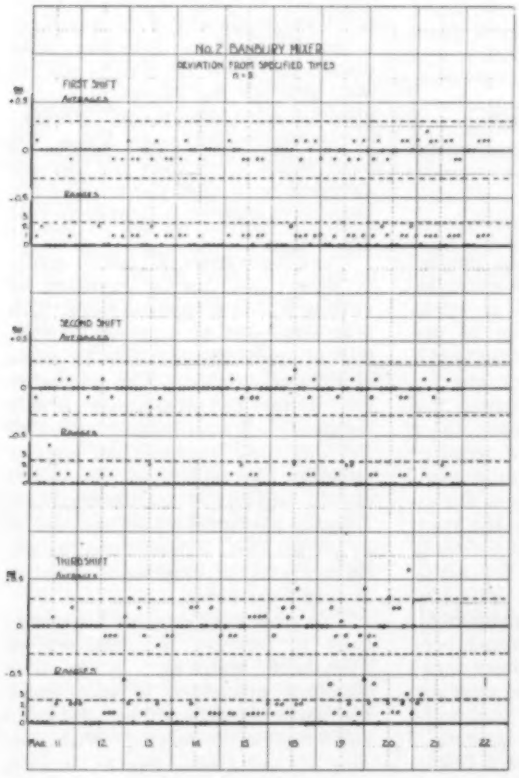

Figure 6

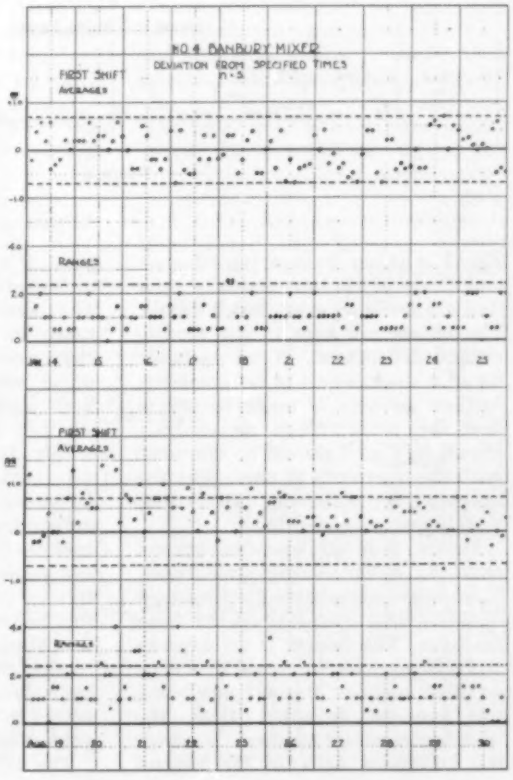

Figure 7

Usually it is not practical to keep the operators informed of these things. Thus the lack of quality consciousness is quite widespread.

Management is largely to blame for the situation. That means everyone from the supervisor up. Often an operator does not know exactly what is required, or he may not have the skill. Frequently no person checks him when he is off the beam and more commonly still, no one praises him when he does a good job consistently.

Process control records contain plenty of data that can be turned to good account if it is personalized.

These charts are posted beside the work station. They bring home to the operator the fact that his work is being watched closely. The effect is similar to a ball player's published averages. Pride of workmanship is stimulated because the rating is based upon factors that are readily understood, and they are directly within the man's own sphere of influence.

Best results come from trying to encourage the good worker rather than scold the poor one although sometimes the latter becomes necessary. Very often poor work is neither willful nor due to carelessness. It may be beyond the operator's control. Figure 7 is an example. The average and range of cycle times in the lower section of the chart are not as good as those in the upper section. The former are for the month of August when the weather was hot. The upper chart is for January when the weather was cold. The more erratic performance during August was due to difficulties encountered by the men, because the temperature of the cooling water was too high for satisfactory processing. When facts like this become known to management, it enables them to take proper corrective action, and sometimes forestalls laying the blame in quarters where it is not deserved. Such misguided actions discourage interest.

The value of control charts lies in their sensitivity to trouble. They are of little use, however, unless management acts promptly on the things that are bound to come to light. Intelligent interest on the part of management is a powerful influence towards stimulating an operator's pride in his work. On the other hand, the improvement in uniformity of mixing cycles shown in Fig. 8 could not possibly be attained without the sincere interest of the man on the job. These two factors must be coupled together to assure success.

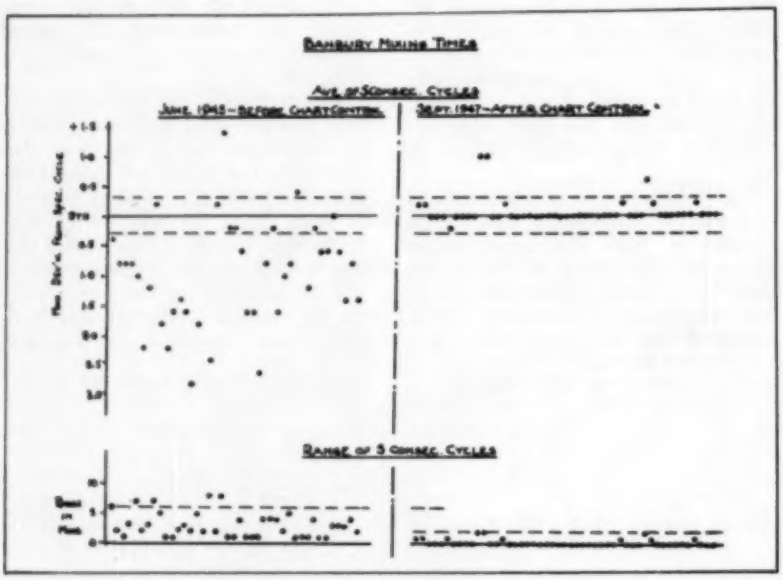
Banbury Mixing Times
Avg. of Second Cycles
June, 1945 – Before Chart Control
Sept. 1947 – After Chart Control
Range of 5 Consec. Cycles

Figure 8

Fig. 3 is taken from a typical control chart of routine viscosity tests that are made on every batch mixed. The charts are kept in the quality control department. If the variability of a stock seems to be excessive, further analysis is made to try to find the cause. Such an analysis, shown in Fig. 5, should be discussed with the operators to emphasize the necessity for following instructions closely and consistently.

Figure 6 is an operator control chart on batch mixing cycle times. It shows comparative performance of three shift operators on the same machine. The record is an average and range chart for each five consecutive batches, the average being the average deviation from the specified mixing time, and the range the difference between the longest and the shortest.

EFFECTIVENESS OF CONTROL WORK

In every organization engaged in production there is a vast number of examinations made on the process, and materials being processed in the course of a day, every day. All this checking taken together forms the structure by which quality is controlled. How it is used determines in large measure, the success of the organization in maintaining its quality on a satisfactory level.

Every time anyone looks at an instrument, examines material, or checks the process, you are buying information. Much of this investment does not yield a fair return. A minimum is derived from the multitude of casual checks made by people throughout the day and of which no record is taken. In many cases this is the only control exercised, yet at the end of the day there is no information regarding what deviations have occurred, nor in fact whether the necessary checks have actually been made. Whether or not the appropriate action has been taken often does not become apparent until after the product has been completed—but then it may be too late.

The effectiveness of general quality supervision can be improved by putting it on a systematic basis. This is accomplished by organizing a routine of spot inspections to be made at regular intervals. The frequency may be tied to production or it may be made on a time basis, running all the way from once per half hour to once per day or longer. A record should be kept of the observations. Usually a control chart will be of value to provide continuity to the history and to emphasize unsatisfactory conditions.

This idea has been used successfully to improve the accuracy of compound weighing. It is now standard procedure to spot check the batch weights of chemicals and rubbers prior to mixing. With certain critical stocks every batch is checked. With others, the frequency

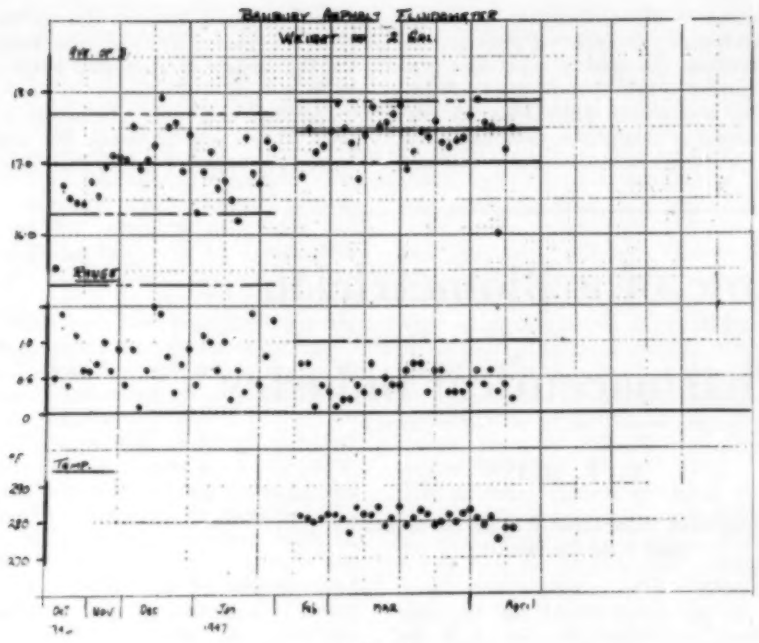

Figure 9

is reduced to several checks per shift. The time at which they are made is random. Here again the operator's interest has been aroused by means of control charts that show deviations from standard weights. This procedure takes but a few hours each day, and the cost represents a small fraction of the trouble it has eliminated.

Figure 9 shows a series of spot checks taken on an automatic metering device. The successive points show variations in the weight of two gallons of liquid asphalt. The second half of the chart shows improvement gained by better temperature control. Spot checks like this made daily and plotted on a control chart are a great help in giving quality assurance.

Figure 10 is a continuous temperature record from the mixing operation. Charts of this type are usually scrutinized periodically and then filed in a drawer, provided maximum specified temperatures have not been exceeded. That is typical batch psychology, but continuity and uniformity of processing are important factors also, and these charts are very difficult to analyze from this point of view. That is particularly true with large variety and short runs, when frequently some stocks do not repeat before several days or maybe weeks have passed. Consequently, temperatures are read off the original chart at three important stages of each cycle, and replotted on control charts that are maintained for each of the critical stocks. By plotting averages and range of five consecutive batches, it is possible to condense the data to accommodate a year's production on a single chart. It is a simple matter to maintain an individual chart for each stock, and by this means, quality is interpreted as a running record rather than as a batch by batch acceptance.

The temperature charts serve another purpose. It will be noted that each hump on the chart is a complete batch cycle time and provides a convenient means for checking the operator's conformance to the specified cycle time. For this purpose, the batch times are scaled off in groups of five and the average deviation from standard and the range between the longest and shortest are plotted on a control chart. Figures 4, 6, 7 and 8 were compiled in this way.

It might appear that the time spent in replotting instrument charts is unwarranted. It should be kept in mind however, that the work can be done by a clerk, and once it has been done, it greatly shortens time and clarifies interpretations that may be made by higher priced personnel. The information is also comprehended better by the operators. The work can be kept at a minimum after stability has been attained by applying sampling principles to the mass of original data. By this means, control is maintained by analyzing a small percentage of the total available data on hand.

CONCLUSION

The illustrations given in the text are just a few examples of many that could be presented of a similar type. The charts were selected from earlier periods, because that was the most interesting stage when progress was sometimes spectacular.

The plant they were taken from uses 35 different kinds of rubber, and about 300 different chemicals. These are combined to form over 1000 different compounds of varying physical characteristics. Currently there are over 3000 control charts in active use in the compound weighing and mixing departments alone. These cover the routine and special testing of color, specific gravity, hardness, viscosity and the physical characteristics. In addition to this, there are operator control charts posted beside every operation

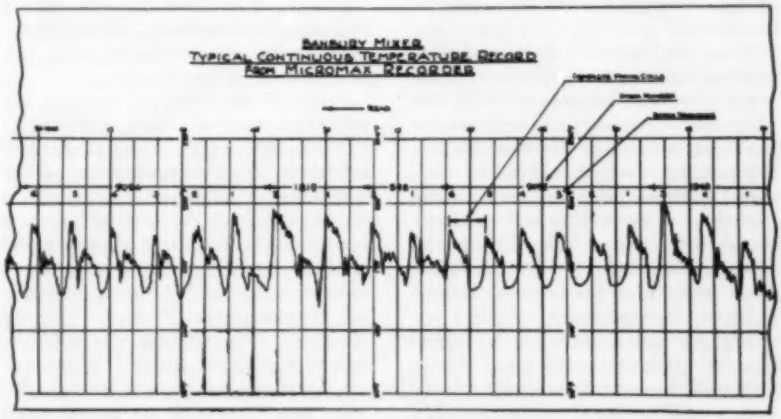

Figure 10

to indicate the individual quality performance of each man in the department in respect to some important phase of his work.

The charts have become an indispensable tool to the operating and technical staff. Of greater importance is the service they are performing in creating operator interest in the quality aspects of production. These factors together with the underlying philosophy as discussed in this paper, have combined to accomplish a substantial decrease in off-standard batches during the past six years. During that time, the percentage of suspected batches held because of failure to meet qualifying tests has decreased by over 75 percent to reach the best level ever experienced by the plant.

The Role of a Biometrician in the Pharmaceutical Industry

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The only word in my title that may be new to some of you is "biometrician," so perhaps I should begin with a definition. In general, a biometrician is a scientist concerned with the statistical and mathematical aspects of biology. In the development and manufacture of drugs—defining the term broadly to include the vitamins, hormones, biologicals, antibiotics and related preparations—he is concerned primarily with the design and evaluation of experiments with a living indicator, such as a bacterium, an animal, a plant, a bacteriophage, an isolated tissue or a human patient. Although the dose of drug may be known exactly from chemical or physical measurements, the response is subject to a type of variation which the biometrician is especially qualified to handle. In other experiments the reaction may not be measured biologically, but the biological origin of the drug often calls for a similar approach.

Thus his subject matter distinguishes him initially from statisticians who are concerned with the chemical, physical or engineering problems arising in the manufacturing process. Nor should he be confused with statisticians who handle questions of marketing and economic forecasting. From his duties, the biometrician belongs on the same team with the biochemist, immunologist, bacteriologist, clinical investigator and manager of biological control, in short, on the team of professional biological scientists upon which the industry depends. His contribution, however, differs from that of any of these, as will be evident from his qualifications.

QUALIFICATIONS

We may consider the qualifications of a biometrician in the pharmaceutical industry in terms of his training and of the statistical and mathematical methods he should be able to use. Ideally, he should have a Ph.D. with a major in statistics and a minor in pharmacology or biology. Under statistics, he will need especially courses in experimental design and analysis and at least an introduction to mathematical statistics. His mathematical background should be as strong as possible, so that he can read and apply new techniques as they are developed. Moreover, biometry includes the mathematical as well as the statistical aspects of biology and these are bound to crop up in time. Biology, however, is almost equally important and for our present purpose should include pharmacology, bacteriology, physiology, biochemistry and the background sciences.

In the drug industry many of the statistical methods that a biometrician should be able to use effectively fall under the general heading of the statistics of bioassay. Although a development of the last 20 years, a considerable literature of papers and books has developed, ranging from slender volumes[7,19] to the extended treatment in Finney's "Probit Analysis" [20] and "Statistical Methods of Biological Assay."[21] In applying these techniques, he will design experiments so as to segregate extraneous sources of error. He will estimate the number of observations needed for a given precision. He will compute tests of significance and confidence limits under varied conditions. He will plan factorial experiments for studying several factors simultaneously. When the experimental results can be obtained serially, he will proceed sequentially, so as to minimize the number of observations. In applying these methods, he will use the analysis of variance, regression, interval estimation, covariance, variance components and other statistical tools. Applications of many of these may be found in the proceedings of a conference on the place of statistical methods in biological and chemical experimentation.[34] Here they will be considered in relation to the stages a new drug must traverse from its birth until it is ready for the market, beginning with research and development.

SCREENING PROGRAMS FOR NEW DRUGS

The research laboratories of a drug house are constantly seeking new drugs, whether synthetic or of natural origin. As each compound is prepared, its biological activity must be tested. Pharmacological screening can be expensive and may take many forms. Prominent among these are tests involving an all-or-none response. For this type of screening, the appropriate design will depend upon how promptly the animal reacts after it is given the drug. When the reaction time is short, the biometrician may recommend a staircase or up-and-down

design. With this technique, the response of one animal to its dose determines the dose to be given to the next animal. If the reaction is positive, the dose is reduced; if negative, the dose is increased, in each case by a constant log-dose step.[20] If, on the other hand, the reaction time is relatively long, a small but constant number of animals, from two to six or ten, may be assigned at random to each of four dosage levels, spaced at equal log-intervals. Tables have been published recently with which the ED50 and its standard error for this particular design can be estimated with a minimum of calculation.[35]

The precision sought in each test will depend in part upon the probable cost of producing the drug and on the risk assumed in missing a potentially valuable product. With an all-or-none reaction, precision can be increased both by adding more animals and by adopting a more penetrating method of statistical analysis,[3, 20] one which will provide a measure of the slope and tests for homogeneity and parallelism. Similar differences in the intensity of screening are available with graded or measured reactions. To recommend the most efficient design for each purpose is one of the many functions of the biometrician.

THE PHARMACOLOGICAL CHARACTERIZATION OF A NEW COMPOUND

A compound that passes the initial screening is then subjected to a battery of pharmacological tests, many of them primarily quantitative. Qualitative experiments, such as for side effects, are usually delayed until the activity of the compound is known. Hence, the first tests are likely to be quantitative determinations of potency. Potency can seldom be expressed satisfactorily in terms of a biological response; the response per se is subject to too many environmental and inherent biases. These are avoided by comparing the reaction to a new drug with the concurrent response to some other drug. Hence an estimate of potency is essentially a comparative bioassay and should be designed statistically and carried out as such. Unless the therapeutic action of the compound is unique, a standard drug in general use serves as the reference standard. In effect it calibrates the assay organisms in respect to their sensitivity.

A drug intended for use against a pathogen, such as one of the antibiotics or antimalarials, is assayed initially *in vitro* with one or more strains of microorganisms and only later in animals inoculated experimentally with the disease. A much higher level of precision is to be expected, of course, in the first type of experiment. In penicillin, for example, the standard error of an individual cylinder plate assay may be less than the laboratory errors in handling the drugs.[5, 11] The situation is quite different, however, when the drug is tested against pathogens in inoculated animals. In tests of antimalarials in ducklings, for example, the percentage of parasitized red blood cells in birds treated alike varied far more than could be accounted by the usual sampling error for an all-or-none response.[32]

With other classes of drug, the pharmacological activity is measured directly. Many examples have shown how the biometrician can increase the efficiency of a pharmacological test. Experiments on vitamin K, for example, have been based upon the clotting time of chick blood. Some investigators thought they could improve upon a published technique by bleeding the chicks twice, before as well as after administering the vitamin K. They reasoned that knowing the initial blood-clotting level of each chick would lead to a more precise estimate of the effect produced by vitamin K. Later statistical analysis proved that just the opposite was true.[10] Here the trauma from the initial bleeding actually reduced the inherent precision of the assay. Or again, a covariance study of the parathyroid assay showed that the initial blood level could be dispensed with in a suitably designed experiment, thus cutting the number of chemical analyses in half.[13] Experimental and biometric studies of the insulin assay initiated by the USP Insulin Advisory Board give promise of reducing the number of blood sugar determinations even more drastically without sacrificing precision. No doubt, many other tests for pharmacological activity could be improved equally by a quantitative study of sources of error, arbitrary assumptions, and laboratory routines, often by simple rearrangements of routine experiments without recourse to additional tests not now provided in the budget.

Before a new drug can be released, its toxicity in the host as well as its potency must be determined. A quantitative estimation of relative toxicity[3, 20] in one species of laboratory animal is not sufficient, however, when the inference is to man. The toxicity of the drug should be assayed instead on several different species. Relative toxicity may differ markedly from one laboratory animal to another, as was observed with certain alkaloids.[15] When this occurs, the new drug's toxicity in man is much more doubtful than if its toxicity relative to a suitable reference standard were the same in all species. Moreover, the new drug is usually tested on healthy laboratory stock although it is to be used in sick patients, adding an additional hazard to extrapolation to man.

Of particular importance is the chemotherapeutic index of a new drug or the ratio of its toxic to its therapeutic dose. When the dose effecting a 50 percent cure is compared with that for a 50 percent kill, the index may be a poor guide, for then it ignores the effect of the slope of the dosage-effect and dosage-mortality curves. A very small slope in one or both of these curves would disqualify a prospective drug. Instead, the chemotherapeutic index should be computed from the dosage curing a high percentage, such as 95 or 99 percent, and killing a small percentage, such as one or 5 percent.[22] The five and 95 percent levels can be interpolated from the curves, with smaller sampling errors than the one and 99 percent levels. Both tend to be less stable than the 50 percent levels, but this limitation can be offset in part and the sampling error of the index reduced by the application of statistical criteria in selecting dosage levels and in computing the results.

CLINICAL TRIALS

After a new drug has performed satisfactorily in animal tests, it is ready for clinical trial. Sometimes samples of a new drug are distributed to selected physicians, who are left to their own devices as to how they shall conduct their clinical trials. Most physicians are ill-equipped either to design critical experiments in this field or to interpret their data. The result may be a series of conflicting reports from which the truth emerges only after a considerable period. Many difficulties could be avoided if all clinical trials were designed and analyzed with the aid of a good biometrician. Some drugs, of course, are so outstandingly effective that the correct answer sticks out like a sore thumb. More often, however, the improvement is less marked and can only be evaluated by careful statistical analysis. There are currently so few clinics that boast the services of a competent statistician or biometrician that in most cases both the drug

and the biometrical advice will have to come from the manufacturer if reliable results are to be assured.

In many clinical trials it is only possible to state that one drug has been more effective than the other in a comparative trial, one of which may be a placebo. In this type of experiment, the necessity of concealing the identity of the treatment not only from the patient but also from the attending physicians and nurses, the so-called "double blind" test, cannot be stressed too strongly. The danger of biassing the outcome in experiments on analgesics and hypnotics has been discussed recently in Science,[1, 2] but it is also important in other areas where the psychological factor may be overlooked, as in testing the effect of anticoagulants upon the number of coronary thromboses and even on the number of fatal outcomes.[23] Without sound original data, no amount of statistical analysis can lead to a valid conclusion.

The experimental results of a clinical trial can often be summarized in a 2 x 2 table. These may show the number of patients cured and the number not cured on each of two alternative treatments or may take several other forms.[8] The analysis differs with the design but leads in each case to an estimate of the probability that the observed results might have occurred if there were no inherent difference between the two treatments. Mosteller[28] has recently noted some of the precautions needed in tests of this type with analgesics.

When many factors are involved, the data cannot be summarized in a single 2 x 2 table. Instead we have a complex contingency table with computational difficulties at the professional level. This occurred, for example, in a comparison of ether and cyclopropane anaesthesia in relation to the incidence of circulatory complications after abdominal operations.[18] The outcome depended upon a number of conditions, such as the site of the operation (upper or lower abdominal), status of the circulatory system (normal or abnormal), and degree of complication (major or minor). A tendency to use each anaesthetic in a particular type of case could bias the conclusions if the different factors were not isolated.

When the results can be determined only after a long delay, the number of cases needed for discriminating between treatments has to be estimated in advance. In other trials, however, each result can be assessed relatively soon and then the number of observations can be determined by the outcome. A practicable sequential program has been described recently by Bross.[14] Cases are paired as they appear, assigning the patients in each pair to treatments at random. If both individuals in a pair react alike, either positively or negatively, that pair cannot contribute to discriminating between the two treatments. Discrimination depends on the pairs in which one patient reacts differently from the other. The physician makes four decisions in advance, probably with the aid of a biometrician:

(1) how much better must the new remedy be before he would consider it an improvement,

(2) what is the probable rate of cure with the standard or control preparation,

(3) what protection does he want against concluding that there is a difference when none exists (against making an error of the first kind), and

(4) what risk will he assume of missing a real difference by calling the two drugs alike when in fact they differ (an error of the second kind).

Given these decisions, a testing scheme can be devised which requires no computation, not even addition, and leads with a minimum number of trials to one of three conclusions: (1) the new drug is better than the old drug, (2) the two do not differ significantly, or (3) the old drug is better than the new drug.

Another danger in clinical experimentation is that the results may be obscured by individuals whose reaction is irrelevant, as shown by Jellinek's study of two ingredients in a compound headache remdey.[26] Four identically-appearing kinds of tablets were prepared, one being the complete drug, the second had one ingredient missing, the third lacked a different ingredient and the fourth was a placebo. As patients with chronic headaches came to see their physicians, each was given a package of tablets, to be taken every time he had a headache. He was to note whether or not his headache was relieved within half-an-hour. At the end of two weeks, each subject reported how many headaches he had had and how many of these had been relieved satisfactorily. He was then given a fresh envelope containing one of the other drugs and this was repeated until each patient had tried all four drugs. Neither the patient nor the physician knew the composition of the tablets, which were so distributed that all preparations occurred in the first, second, third and fourth two-week period as determined by a 4 x 4 Latin square.

An analysis in terms of the success rate showed no significant differences among the four drugs. However, it seemed probable that patients reacting positively to the placebo had psychological rather than physiological headaches and, therefore, were not suitable test subjects. The data were then reanalyzed, separating the 120 subjects who reported relief with the placebo from the 79 who found it ineffective. In the first group the success rates were almost identical for the other three drugs, varying from 82 to 87 percent. Among the subjects not reacting to the placebo, the success rate varied from 67 to 88 percent, a significant difference. By omitting the unsuitable subjects, the true clinical effectiveness of the ingredients could be evaluated, the highest rate occurring with the complete drug.

When there are more preparations to test than can be given to a single patient, incomplete balanced blocks offer a solution. This design was used in a comparison for intramuscular pain of six samples of penicillin sodium which differed in their content of impurities.[25] Each patient was injected with three of the preparations at three-hour intervals, so that every sample of drug occurred equally often with every other sample. Intensity of the pain following each injection was scored from zero to four by comparison with a symmetrical injection of saline alone. Thus differences between patients could be segregated and, by a factorial plan, the sensitivity of site of injection tested simultaneously.

In other clinical trials, the magnitude of the response may depend upon external factors which could modify the conclusions rather importantly but which require statistical analysis for their discovery and measurement. In experiments at the Cornell University Medical College, the dose of digitoxin which just produced a recognizable change in the RT-T segment of the electrocardiogram was determined in each of 89 patients, ranging in age from three to 74 years. An initial report[27] indicated that 50 percent more digitoxin was required in children than in adults to produce a just detectable response, but this apparent contrast between children and adults vanished when the same observations were reanalyzed by partial regression and covariance.[9] Here the

age effect was due solely to an incorrect adjustment for differences in size. In the first report the dose per patient was divided traditionally by his body weight; in the later analysis by the square root of body weight as determined by statistical analysis. The relation of dosage to body size may differ with the type of drug but its correct evaluation in each case might resolve perplexing differences between competing drugs having the same type of action.

Many of the basic principles of biological assay are as applicable in the clinic as in the laboratory. In a recent study on the potency of mercurial diuretics with patients in congestive failure,[24] the experiment was arranged in randomized groups, each group representing the reactions of a single patient to two or three different doses of each drug, given in a random order. The weight loss in quarter-pounds 24 hours after each administration of drug served as the response. Since known differences in the dosage of each drug produced highly significant differences in response, bioassay procedures could be used to measure how much of each new drug was required to produce the same weight loss as a specified dose of the standard drug. When clinical experiments of this type can be carried out effectively, they are perhaps the most informative of all in assessing the relative potency of a new preparation.

SOME TOPICS IN PHARMACOLOGICAL RESEARCH

Many problems arise in the pharmacological research laboratory of a manufacturer, where aid from a biometrician could be invaluable. One of these concerns the presence of synergistic or antagonistic action in a drug combination. Drug combinations are sometimes patented and they must then be shown to have an enhanced effect over what would be expected if each component were to act separately.[4,30,31] This requires setting up suitable mathematical models and testing the response observed with a mixture against that predicted from the reaction to the same drugs when they are applied separately. Unless the mixture shows a significantly greater (or, in the case of antagonism, smaller) effect than can be predicted from their action alone, no claim of synergism (or antagonism) can be sustained. Those of you who have read the recent contributions to this subject need no convincing that here is an area where the services of a good biometrician are indispensable.

In the search for new drugs, series of related compounds are often evaluated quantitatively, even though they offer no early prospect of clinical value. Such observations may lead to a better understanding of the mode of action in relation to chemical structure, which in turn can guide the research chemist. When these compounds are tested over a period of years, the comparison of results obtained at different times is open to question. A case in point is the relative potency of α-antiarin and β-antiarin in cats.[16] These isomers seemed to differ significantly in terms of their LD50's when tested six months apart (26.2 ± 7.2), but the difference vanished when they were retested concurrently (3.1 ± 6.7). The initial significant difference was apparently due to unequal sensitivity in the test animals on the two occasions.

Bioassays have a theoretical appeal to the biometrician. Ordinarily when he draws inferences concerning an underlying population and computes confidence limits measuring the range of his uncertainty, he cannot check his procedures objectively. This limitation does not exist in bioassays of known but undisclosed concentrations of drugs, where he can determine experimentally whether his estimated confidence limits are operating as he would predict from his mathematical models. This same principle of known unknowns has also been introduced into many collaborative experiments for validating a method, such as those sponsored by the U. S. Pharmacopoeia. Here the services of the biometrician have been called upon repeatedly.

IMPROVEMENT OF THE PRODUCTION PROCESS

Another area where a biometrician may be extremely valuable is in the improvement of a production process. These may be pilot plant studies or conducted with full scale equipment. Where the product depends upon the growth of an organism, as in the production of penicillin and other antibiotics, the biometrician has important assets. He will be familiar with devices such as sequential experimentation and fractional factorial designs. How the latter may be applied to improving the yield of penicillin has been described in two recent papers,[17,34] where a relatively small number of experiments led to marked gains in yield.

BIOLOGICAL STANDARDIZATION

A number of important drugs must be standardized biologically in production, although as our knowledge increases, bioassays are often replaced by physical and chemical techniques. This is a function of the control rather than the research laboratory. In each case the active constituent in a batch of drug is assumed to be chemically identical with the reference standard, but present at an unknown concentration in an inert carrier. The objective of the assay is to determine its relative potency for use in adjusting the concentration or the labelled claim of the finished product. This implies an analytical bioassay, which is to be differentiated from the comparative bioassays discussed previously. In analytical assays, the same relative potency should be obtained for a given new batch of drug no matter what the species of animal, the route of administration or the environmental conditions.

The assumptions in an analytical assay do not hold in most comparative assays, where we know in advance that the unknown and the reference standard differ qualitatively, or, for that matter, in many of the assays described in the Pharmacopoeia, which ideally should be analytical. On the contrary, in most official assays almost every detail is specified. In addition, each individual assay is self contained. Frequently, however, the assay procedure itself could be placed under quality control within a given laboratory. This not only would provide a continuing check upon the testing procedure but would also increase the precision of the estimated potency, within the framework of USP requirements. Let us see how this might operate.

Many routine determinations of potency depend upon a graded response by the test organism. Two or more dosage levels are administered of the standard, or of both the standard and the test preparation or unknown, from which the relation between the measured response and the log-dose of drug can be determined. This relation must be known before the difference in the mean response to the two preparations can be converted to dosage units. The assay process is characterized by three basic statistics. The first of these is the slope (b) of the dosage-response curve with the dose measured on a logarithmic scale and the response on a scale that has been shown to give a linear relation in

developing the assay technique. The standard deviation (s) is the second statistic, computed from the variation in the response: it is essential for estimating the confidence limits of the assayed potency. The precision of the assay depends upon the ratio of these two statistics, or upon $\lambda = s/b$. Finally, when the dosage-response curve is determined for both preparations, their parallelism can be tested statistically. Divergence in slope may be due to a poor experiment or to a qualitative difference between the two preparations. In either case it is a warning sign that usually calls for a repeat assay.

These key statistics are determined repeatedly as an integral part of each assay, but not infrequently the slope and standard deviation reveal a very useful stability when plotted on separate quality control charts. When the slope remains stable over a series of comparable assays, its combined value is determined with increasing precision. Soon the sampling error of the combined slope contributes negligibly to the confidence limits of potency. These may then be computed with a relatively simple equation. Similarly, the standard deviation may show no significant change for months or longer, due presumably to stability in the random factors upon which it depends. Especially when it is determined repeatedly under identical conditions, the so-called inefficient estimates from the range or modified range are adequate and much easier to compute. Occasionally, both the standard deviation and the slope are unpredictable but their ratio ($\lambda = s/b$) is stable. Although less satisfactory than when the components are constant, a λ in control can still better the precision of an assay.[7]

In most assays the standard deviation of a graded response is not only assumed to be stable from one dosage level to another but also to be distributed normally. This was tested quantitatively in a recent study[12] of the liver glycogen assay of adrenal cortex extract. Adrenalectomized rats were assigned at random in groups of five to the different dosage levels and preparations. From the known distribution of the range in samples of five from a normal population, the observed variation in response could be tested for agreement with the normal curve, even though the sample means differed widely. Other cases might be cited where techniques for testing the assumptions in an assay have been contributed by the biometrician associated with the project.

BIOLOGICAL INSPECTION TESTS

Toxicity or safety tests are required for a number of drugs, among them penicillin G. Their purpose is to identify any toxic lots. The present official procedure would be more effective if larger test doses were used. Here again the problem is essentially biometrical. By increasing the dose and "calibrating" each new lot of animals with a standard preparation, any toxicity in a batch of drug could be distinguished from exceptional sensitivity in the test animals.[33]

Statistical considerations are also involved in tests of sterility, especially of the antibiotics.[33] When the same lots were tested both by a manufacturer and by the Food and Drug Administration, their results on sterility generally agreed in respect to the average percentage contamination for any given manufacturer. However, the lots called "defective" were not the same in the two laboratories. Apparently, the testing procedure was not sufficiently sensitive to separate the defective lots from those which met the sterility standards. Positive identification would require an inordinately large number of tubes. A proposed solution was to test sterility on a grand lot basis, first establishing tolerances, degrees of risk, an acceptable level of contamination greater than zero percent, and an agreed risk of exceeding that level. This should assure the quality of a manufacturer's product as a whole and provide adequate protection for the public. Here again effective work by biometricians in the pharmaceutical industry could be instrumental in improving official standards.

Bioassays for standardization should be distinguished from adequate inspection or pass-and-fail tests. Biological standardization leads to estimates of potency with a known precision. Pass-or-fail tests would be concerned with checking labelled claims. Although they may use the same laboratory procedures, the latter would have the more stringent requirements before they could meet modern inspection standards. Thus the testing process must be demonstrably in statistical control in respect to the standard deviation and the slope of the dosage-response curve, so that a given difference in the mean response will correspond to a constant difference in potency within a known sampling error. Consumers' and producers' risks must be adopted, together with a specific sampling plan. An operating characteristic curve would be prepared and then the pass-or-fail test would be ready to go. At the present stage of bioassay it seems easier, although possibly less efficient, to assay for potency and pass or fail a lot from its conformity to established tolerances.

CONCLUSION

From this brief review of the role of a biometrician in the pharmaceutical industry, it should be evident that his services are needed in nearly every stage, in research and development, in clinical testing, in developing biological production processes, and in the control laboratories for biological standardization and control of product quality. The pharmaceutical manufacturer should find him an indispensable member of his team.

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Perception, Preference, Judgment—Clues to Food Quality*

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The food industries have been late-comers in the use of statistical quality control. As yet their contributions both to its development and to its popularity have been minor. Because the food industries cover such a vast array of different types of operations in both processing and distribution, this statement bears the distinct flavor of generalization. Some members of the industry have always been as aware of the new discipline as anyone else but the statement is generally true. The reasons for this lateness are many and varied; also, they are probably valid. Although it is not our present purpose to inquire into them, this paper does touch on one believed to be significant.

FLAVOR QUALITY CONTROL

Flavor and its corollary, consumer acceptance, represent one of the most important aspects of food quality, and it is precisely here that we find a serious obstacle to attainment of the benefits of the new science. Adapting the principles of SQC for control in this field requires the solution of new problems.(1) Obviously, the functioning of a statistical quality control system depends upon having data which can be dealt with statistically. Food processing involves many operations where such data are available through standard methods of measurement, but in the realm of flavor quality and consumer acceptance data which are statistically usable have been the exception rather than the rule.

One cannot assert that there has been no flavor quality control. Constant awareness and concern with the flavor problem is a common phenomenon. Great effort is sometimes expended on flavor control, sometimes with good results. But the methods used have been highly varied and usually inadequate. There have been no flavor measurement systems which could be called

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"standard" and the use of methods whose data would be amenable to statistical control techniques has been rare indeed. A necessary first step is to establish precise and reliable methods of measuring flavor and acceptance variables. In this paper we propose to demonstrate some of the possible solutions of this problem and show how the resulting data may be handled by the usual SQC methods to give improved control.

PSYCHOLOGICAL FACTORS

Flavor cannot be defined or measured except in terms of the human response, since flavors are what people perceive them to be—no more, no less. This idea is not unusual; the layman seldom thinks otherwise. But physical scientists frequently make the mistake of treating flavor as if it were a physical thing. It is true that many flavor variables have neat physical and chemical correlates whose control will represent partial flavor control, but flavor is not simply a special branch of chemistry and we are vastly ignorant of the equations for transferring the one kind of information into the other. Favor may vary significantly when even the best physical methods reveal no differences, but such changes can be measured by means of human behavior.

Flavor itself is a relatively stable aspect of foods and can be defined by means of relatively stable aspects of behavior. However, the real problem is not flavor but the effects of flavor, as combined with other factors, on consumer behavior. To the manufacturer the most practical aspect of food quality is the resultant level of consumer preference. Flavor, objectively considered, is the most important single factor in determining this level, but people's attitudes, habits, knowledge, and opinions, and many other things help determine over-all acceptance. Although it is not feasible to control a product by direct reference to all of these factors, it is possible to estimate their resultant by observing the immediate effect of the food on people's behavior in a simple test. The preference test is the most common. The latter is absolutely controlling, since if preference is low, consumer acceptance will not be good even though all other contributing factors are optimum.

All flavor testing depends basically on sensations—taste, smell, feeling, temperature, and sometimes vision—but as combined into complex perceptions. Some tests may go no farther and test results are verbal reports about perceptions or counts of units of behavior based on them. Such tests only describe, they do not evaluate. More often the problem is to evaluate foods, and then we must be concerned with what people do about their perceptions of flavor. Here we must deal with such psychological content as liking and disliking, preferences, and judgments which relate a person's perceptual data to his past experience. The best clues we have to food quality are found in human perception as elaborated into preference and judgment.

There is no startling novelty in this view. Those who have dealt with flavor in the food industries have, in general, recognized both the presence and the importance of the psychological factors, but all too often this has resulted only in the defeatist attitude that flavor must remain an art because of these elements of subjectivity. This attitude will not allow flavor control to be scientific except as it depends on physical variables.

APPROACHES TO FLAVOR TESTING

The different approaches to the flavor quality problem may be placed in a three-way classification, even though it is not authoritative and will call forth disagreement. Nor do all flavor control systems fit neatly in it. First historically, and least complex, is the expert approach where one or a few persons make all the decisions about flavor and quality on the basis of their own sensory data and their personal knowledge. The "experts" may be persons who are trained in flavor work, or they may simply perform as such by virtue of their jobs—brewmasters, chief chemists, vice-presidents in charge of production. Almost every food processor has at least this minimum level of control and many still believe in it firmly. The system is cheap, rapid, and flexible, but too often the information it provides is not sufficiently reliable to permit adequate control.

The small panel approach, at the next level of complexity, begins to rely on method rather than authority for its results. Because of the crudeness of our classification we must include quite a diverse population of systems here, but all are typified by the use of small groups of trained persons in testing work. There are broad differences in methods and in the precision and general usefulness of results. The data can be handled statistically if the system is made to function for that purpose, but most are not. The small panel retains many of the advantages of economy and flexibility typical of the

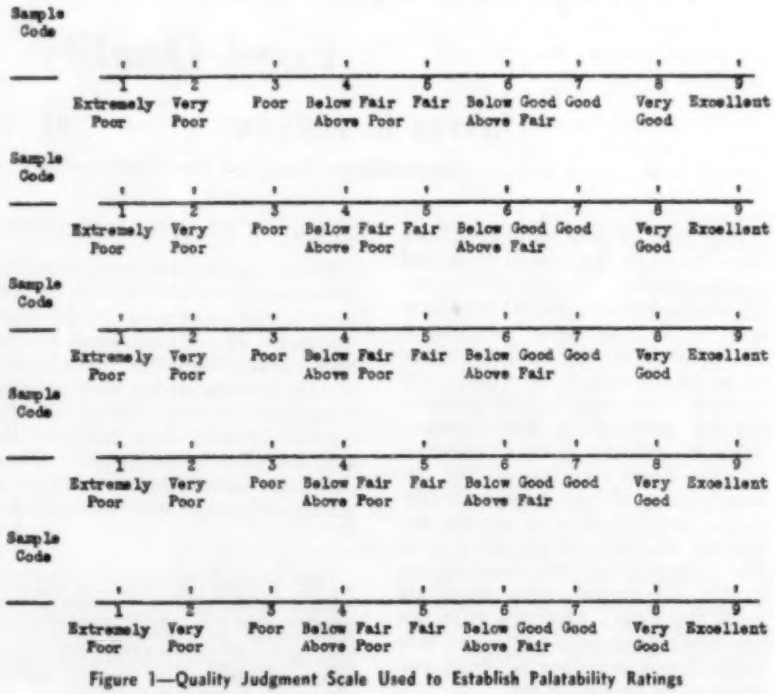


Figure 1—Quality Judgment Scale Used to Establish Palatability Ratings

expert approach; also, many of its faults.

The third stage may be called the laboratory approach. Adequate facilities are most important here, although their presence is not the distinguishing feature. This approach is typified by more carefully controlled testing conditions, methods which are gaged to particular problems, panels of adequate size, and the use of sufficient data to provide reliable answers. The presence of such a system in an organization indicates a serious interest in flavor measurement. Its disadvantages are that it requires special facilities and trained personnel, is expensive compared to the other approaches, and is likely to seem unduly cumbersome and rigid to production people who were trained under more flexible methods. However, it can produce reliable data which are amenable to statistical interpretation, hence it provides the most accurate flavor control that is now possible.

Awareness of the importance of methodology is increasing among adherents of all three approaches. All three deal with the same psychological elements, but these are personal, subjective phenomena varying from one person to another, and the systems differ in the way they observe and quantify the basic data. It has been the lack of standard and reliable methods which more than anything else has accounted for the slow growth of scientific quality control in this field.

ESTIMATING CONSUMER PREFERENCE DIRECTLY

The final objective of flavor quality control is always to achieve and maintain good consumer preference, but there are different ways of approaching this goal. Product lots may be evaluated directly in terms of acceptance, but usually an estimate based on the judgments of a trained panel is substituted for actual consumer tests since the latter are expensive and time consuming. There are various indirect approaches which require that an intermediate goal be established whose attainment will assure good consumer preference. Although they usually permit more precise control, their basic value depends upon the validity of the intermediate goal. Intermediate goals that may be used are: (1) identity with a physical standard, (2) conformity with a subjectively defined flavor type, and (3) simple elimination of flavors which are obviously foreign to the product.

The common method for making direct estimates of consumer preference is the rating scale. The method has broad utility and may be used to measure almost any subjective factor that can be quantitatively understood by the test subjects. Rating scales may vary considerably in details of construction and manner of presentation without destroying their usefulness. The rating scale which is in common use in our laboratory for evaluating food quality is shown in Fig. 1. This form is designed for use with panels who have been selected and trained. For straight preference testing with unselected consumers we use a scale where the points are described in phrases indicating successive degrees of liking and dislike.[3] It is assumed that the panel member will rate samples not only on the basis of his own likes and dislikes but also according to his knowledge of what constitutes good quality in the product. The difference in scales is more a logical consideration than a matter of necessary experimental control for it may be shown that panel members give essentially the same results with either scale. It is the panel members' training and experience and not the scale which makes the difference. This quality judgment method must be considered less valid than the preference method because it uses a small and constant panel; however, the variability of the responses tends to be less. Its purpose is to predict from the judgments of from 15 to 20 people the result that might be obtained with the preference method using about twice as many untrained consumers. To evaluate the results the numbers 1-9 are assigned to the successive scale points. The average of the values checked for a given sample becomes its quality index and the standard deviation is available as the measure of variability.

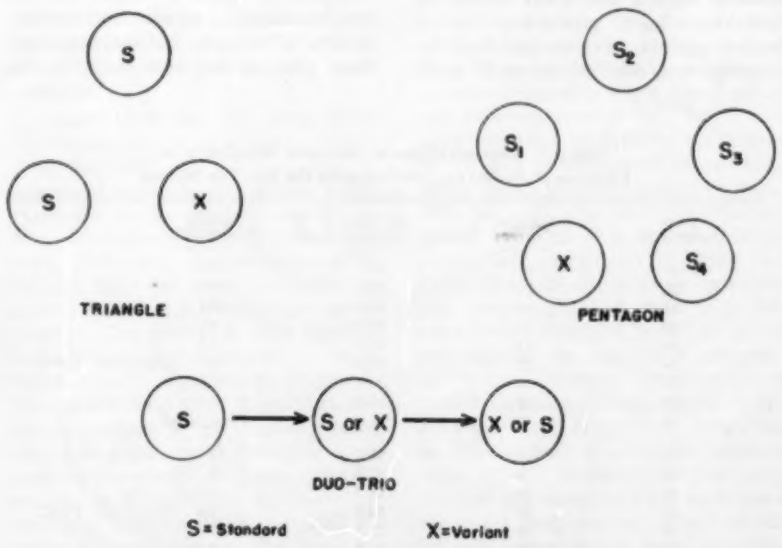


Figure 2—Discrimination Test Methods for Measuring Sensory Differences Between Samples

IDENTITY WITH A PHYSICAL STANDARD

The best of the indirect approaches to control is that of requiring complete identity with a physical standard. It requires certain conditions all of which can seldom be met: (1) consumer preference for the standard must be assured, (2) it must be possible to preserve the standard without change, (3) management must be willing to reject products that are better as well as those which are poorer than the standard, and (4) production must be normally in such good control that it can afford such a standard. When these conditions prevail it is possible to use relatively simple test methods in which the subject's task is only that of detecting differences. Measurement is more accurate since personal variability of judgment does not enter. Any one response

means the same as any other and better statistical hypotheses can be made about the data.

TESTING METHODS

Figure 2 diagrams three of these difference testing methods. In the triangle test, which is probably more widely known than any other sensory testing method, three samples are presented together, two of them being identical standards and the third an "unknown." The subject is instructed simply to pick out the odd sample. The duo-trio test was originally contributed by the Joseph E. Seagram Quality Laboratory.[4] In this method the three samples are presented in succession at controlled time intervals. First comes a known standard, followed by another standard and an "unknown" presented in random order. The subject's task is to determine which of the latter two samples is different from the standard. The pentagon test is a special variation which we have used only in research problems, but which should be useful for quality control work in situations where no single standard is appropriate. The "unknown" (X) is presented along with four standards (S1, S2, S3 and S4) which are not completely identical but have been selected to cover the range of variation which may be allowed. The subject is able to identify "X" only if it does not belong to the "flavor family" represented by the four standards. The method is not well suited for taste tests because of the confusion which results from attempting to taste and remember so many samples, but works quite well with odor or visual problems.

For good results all of these tests require from 16 to 20 subjects, although a smaller total number of persons may be used if some subjects repeat the test to give the required total judgments. If the "unknown" is not different from the standard, a certain proportion of correct identifications will result from chance alone—33⅓, 50, and 20 percent in the triangle, duo-trio, and pentagon tests, respectively. The control limit is set according to the desired statistical significance level. Control tables to interpret numbers of correct identifications as significance levels for panels of various size can be set up by several methods, such as the "t" test, chi-square, critical ratio, or binomial expansion. The proportion of correct identifications constitutes a rough measure of the amount of difference between unknown and standard, since, as the amount of difference increases, the probability of its being detected by more subjects also increases. However, it cannot be considered a very sensitive measure of amount of difference when obtained from a small number of subjects.

Another test method, called "flavor identification," is mentioned here briefly since an example of its use will be given later. The test subject is presented with a single sample and is instructed to report whether a certain flavor or other characteristic is or is not present. It may be used either for assuring that a desired flavor is present in a product or for determining the extent to which an unwanted flavor is present. Panel members require little training for this test. Fifteen to 20 judgments are obtained for each sample. The method of establishing the standard and control limits is explained below in connection with an actual industrial problem.

Model systems may be constructed with relative ease on the basis of what is known about sensory testing which would be theoretically suitable for flavor quality control in certain situations, but such systems are not very convincing until their effectiveness has been demonstrated. That is what we propose to do for three of the methods described.

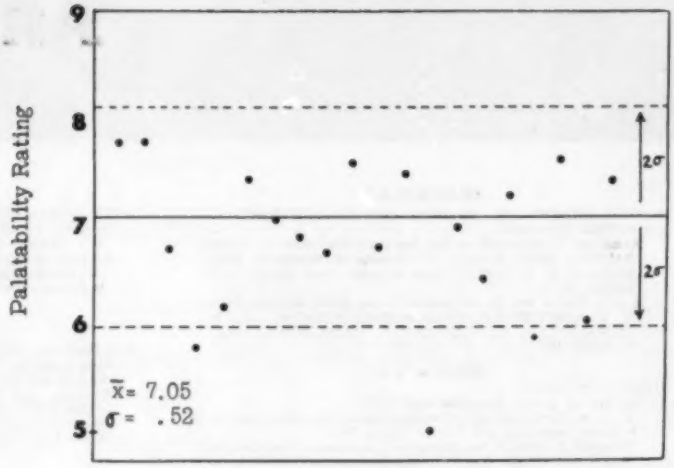
Two of the country's leading distilleries are now using a very effective flavor quality control system based on the indirect approach. It has been described in detail elsewhere.[2] Both systems require complete identity with physical standards which are established by preference testing for each brand of whiskey. Each production lot is tested against its own standard by the duo-trio method, using 20 to 30 judgments by trained panel members. When a difference from the standard can be established at a pre-determined level of significance, the lot is rejected and must be reprocessed. Table I has been adapted from the article referred to above and shows the chart used by laboratory personnel for interpreting results and determining approval or rejection. For example, in a 20-judgment test, 15 correct identifications is the minimum calling for rejection. The last column gives the probability of obtaining the same result by chance if the production lot were identical with the standard. Note the 1.4 percent probability that a lot identical with the standard will be rejected. However, this figure does not reflect all of the producer's risk. Because of the sensitivity of the test method many lots will be rejected which would never be judged poor quality by the consumer even if he used the artificially high standard of complete identity with the flavor type. Therefore, the actual "consumer's risk," while unknown, is very low.

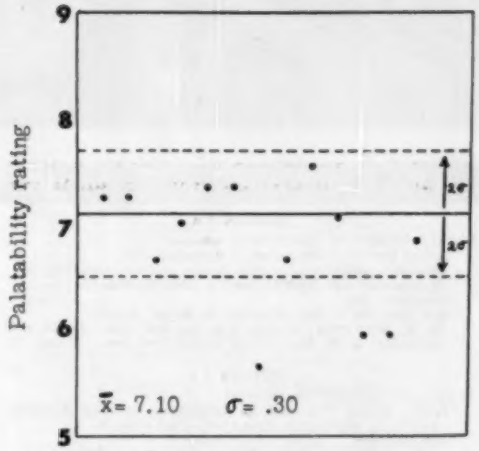
QUARTERMASTER CORPS PROBLEMS

Further examples are provided by our work at the Quartermaster Food and Container Institute. They show the application of sensory testing methods to the problem of the quality control of purchased foods. There are restrictions in Army food procurement which make the quality problem somewhat more difficult of solution than it needs to be for private industry. For the most part, the Armed Services cannot operate by locating a single satisfactory source of supply for an item and then placing the responsibility for

TABLE I. Reference Table to Determine Acceptance or Rejection of Production Lots Tested by the Duo-Trio Method

Total Judgments	Number Correct	Per Cent Correct	Chance Probability	
20	10	50.0	50.0	
20	11	55.0	34.4	
20	12	60.0	18.4	
20	13	65.0	9.7	
20	14	70.0	3.6	
20	15	75.0	1.4	(Rejection Point)
20	16	80.0	0.5	
20	17	85.0	0.1	
20	18	90.0	Very small	
30	18	60.0	13.6	
30	19	63.3	6.7	
30	20	66.7	3.6	
30	21	70.0	1.4	(Rejection Point)
30	22	73.3	0.4	
30	23	76.7	0.2	
30	24	80.0	Very small	





LEFT: Figure 3—Control Chart for Palatability Ratings of Candy, Type A

RIGHT: Figure 4—Control Chart for Palatability Ratings of Candy, Type B

quality control on the manufacturer. In most cases no one manufacturer could supply Service requirements. More important, procurement involves open bidding, the contract award going to the lowest bidder who can meet the specification. This puts a heavy burden on the specification to describe the finished product completely. When requirements cannot be specified so that there can be no difference of interpretation, such as with various aspects of flavor and the general factor called "palatability," provision is made for the submittal of pre-contract award samples. These samples are tested in the laboratory to determine whether their flavor and quality conform to the intent of the specification. When a contract is awarded on the basis of such an approval the Quartermaster Inspection Service has available an actual reference standard to which deliveries must conform.

Indices of flavor and palatability are required; also meaningful standards that will apply impartially to groups of products which may differ markedly in the finer details of flavor, although all belong to the same type. Arbitrary standards must be avoided both for reasons of economy and to build up potential sources of supply. The policy is that quality higher than is necessary to meet Service needs shall not be required. This is interpreted to mean that the average quality of commercially available products of the same type must be the standard. Such a standard is established for an item by testing a representative sampling of products available on the market. In special cases, when the item is not available commercially, it is obtained by testing samples produced by various manufacturers according to the military specification.

PALATABILITY CONTROL

The factor for which the specifications often require pre-contract award evaluation is palatability, which can be defined as "the combination of those flavor qualities which tend to make the product pleasing to the consumer." The test method used to measure this factor is the quality judgment scale shown in Fig. 1 with 15 to 20 trained panel members rating each item. The mean value of the assigned ratings becomes the palatability rating for the sample.

Use of these ratings to establish standards and control limits is demonstrated here by the control chart method, since this is the method which we tried initially. However, certain difficulties were noted in its use with this kind of data and it was later replaced by another procedure which will be explained below. Figure 3 shows the distribution of palatability ratings for pre-contract award samples of a special type of candy bar used only in Army rations. Because there is no commercial counterpart of this bar, the palatability standard had to be based entirely on the preaward samples. At first all samples received were tested until sufficient data were available for this purpose. Then the amount of testing could be reduced since it was necessary to test only the low-bid samples from each procurement until one was found which fell within the control limit. In addition, other randomly selected samples were tested to assure that the palatability standard continued to be representative. The standard and control limit shown in Fig. 3 are based on only part of the plotted data, since ratings obtained later during routine control operations have also been included. To establish the control limit, the distribution of ratings for the original set of samples was obtained; then all sample ratings falling 2 σ's or more below the mean of this distribution were excluded and a new mean and σ were computed, based only on the ratings of the "good" samples. The recomputed mean became the standard palatability score and the recomputed σ was used to determine the control limit.

This approach is designed only to screen out gross deviations below average quality as defined by the standard palatability score. This score represents the level of quality which the producer is expected to meet and the control limit is set so that he takes only a small risk (2½%) of rejection when he does meet it. The risk which the customer (the Army) takes has not been considered as such. Obviously, there would be a 50 percent probability of accepting a lot whose "true" palatability rating fell just at the control limit. Exactly what such a "true" rating would mean in terms of the usability of the candy has not been independently determined. It would have to be related in some way to consumption in the field and the degree of pleasure derived by the soldier-consumer; obviously it is not a simple relationship. The system assumes that the borderline

(Continued on page 22)

PROG

SESSION I MONDAY A.M.—9:30-11:30—May 23, 1955

SESSION I A

METALS TECHNICAL COMMITTEE (Sponsor)

"Quality Control in Production of Aluminum Foil"
OSCAR H. BISHOP, Reynolds Metals Company, Louisville, Ky.
Moderator: G. W. ABSON, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Bulk Sampling of Raw Materials in Metals Industry"
W. M. BERTHOLF, Colorado Fuel and Iron Corp., Pueblo, Colo.
Moderator: E. H. EDE, United States Steel Corp., Chicago, Ill.

SESSION I B

STANDARDS COMMITTEE (Sponsor)

"Quality Control Techniques for Establishing Industrial Standards"
RALPH E. WAREHAM, Consultant, Chappaqua, N. Y.

"Test Standards"
J. S. WISERLEY, Socony-Vacuum Laboratories, Brooklyn, N. Y.

"Establishment of Textile Specifications"
OLIVER P. BECKWITH, Fabric Research Laboratories, Boston, Mass.
Moderator: CHARLES J. HUDSON, Consultant, West Boylston, Mass.

SESSION I C

GENERAL INTEREST

"The Process of Learning by Experiment"
EUGENE W. PIKE, Lincoln Laboratory, Mass. Inst. of Tech., Cambridge, Mass., and Raytheon Mfg. Co., Waltham, Mass.

"Some Legal Aspects of Sampling"
FRANK R. KENNEDY, State University of Iowa, Iowa City, Iowa
Moderator: ENOCH B. FERRELL, Bell Telephone Laboratories, Murray Hill, N. J.

SESSION I D

GENERAL INTEREST

"Statistical Inventory Control"
W. F. HOEHNING, Westinghouse Electric Corp., Pittsburgh, Pa.

"Application of Computing Machines to the Solution of Statistical Problems of an Engineering Nature"
W. E. ANDRUS, JR., International Business Machine Corp., Endicott, N. Y.
Moderator: NORMAN KRAVITZ, Schenley Distillers, Inc., Cincinnati, Ohio

SESSION I E

ELECTRONICS AND AIRCRAFT TECHNICAL COMMITTEES (Sponsors)

"Evaluation of Reliability in Guided Missile Systems"
G. R. SAMS, Naval Ordnance Laboratory, Corona, Calif.
Moderator: J. A. DAVIES, General Electric Company, Owensboro, Ky.

"Quality Control Techniques in Aircraft Electrical Wiring Systems"
F. H. HOWARD, Fairchild Division, Hagerstown, Md.
Moderator: ALAN M. HULL, United Air Lines, South San Francisco, Calif.

SESSION I F

GENERAL INTEREST (continued Monday P.M. Session IIF)

"Management of the Quality Control Function"
A. V. FEIGENBAUM, General Electric Company, Schenectady, N. Y.
W. J. MASSER, General Electric Company, Schenectady, N. Y.
Moderator: JOSEPH M. JURAN, Consultant, Tuckahoe, N. Y.

SESSION I G

BASIC CONCEPTS (Education and Training Committee Sponsor)

"Variables Theory"
ROBERT W. BOEKE, Deere and Company, Ottumwa Works, Ottumwa, Iowa
IRVIN W. SCHOENINGER, Centralab, Milwaukee, Wis.
Moderator: JOHN G. RUTHERFORD, Lear, Inc., Grand Rapids, Mich.

Luncheons—Monday P.M.—12:15—May 23, 1955
CHEMICAL DIVISION LUNCHEON
Speaker: W. L. GORE, E. I. duPont deNemours and Co., Wilmington, Del.
"Contributions of Statistical Methods to Chemical Enterprises"

GENERAL LUNCHEON
speaker to be announced

SESSION II MONDAY P.M.—2:00-4:00—MAY 23, 1955

SESSION II A

METALS AND ADMINISTRATIVE APPLICATIONS TECHNICAL COMMITTEES (Sponsors)

"Quality Control as an Administrative Aid"
C. A. BICKING, Department of the Army, Office of Chief of Ordnance, Washington, D. C.
Moderator: CARL E. NOBLE, Kimberly-Clark Corp, Neenah, Wis.

"Steel Mill Processes and Statistical Attributes Sampling Plans"
H. T. OATMAN, Allegheny-Ludlum Steel Corp., Brackenridge, Pa.
Moderator: WILLIAM P. GOEPFERT, Aluminum Company of America, Pittsburgh, Pa.

SESSION II B

CHEMICAL DIVISION (Sponsor)

Panel on: **"Statistical Quality Control in the Chemical Industry"**
E. C. HARRINGTON, JR., Monsanto Chemical Company, Springfield, Mass.
HILLMAN C. HARRIS, E. I. duPont deNemours and Co., Penns Grove, N. J.
B. H. LLOYD, Lortham and Simpson, Ltd., Montreal, P. Q., Canada
M. H. REPLOGLE, The Davison Chemical Corp., Baltimore, Md.
E. G. SPADER, E. I. duPont deNemours and Co., Parkersburg, W. Va.
H. L. WEHRLY, The Dow Chemical Company, Midland, Mich.
Moderator: MARTIN A. BRUMBAUGH, Bristol Laboratories, Syracuse, N. Y.

SESSION II C

TEXTILE DIVISION AND BREWING INDUSTRY STEERING COMMITTEE (Sponsors)

"Humanized Communications Can Overcome Resistance to Change"
RALPH E. BURT, National "U" Association, Springfield, Mass.
Moderator: D. S. HAMBY, North Carolina State College, Raleigh, N. C.

"Quality Control and Its Application to the Bottle Washing Process"
W. H. vonMEYER, Barry-Wehmiller Machinery Co., St. Louis, Mo.
Moderator: PAUL K. LEATHERMAN, Falstaff Brewing Corp., St. Louis, Mo.

SESSION II D

GENERAL INTEREST

"An Over-all Quality Assurance Plan"
E. G. D. PATERSON, Bell Telephone Laboratories, New York, N. Y.

"A Check Inspection and Quality Rating Plan"
HAROLD F. DODGE, Bell Telephone Laboratories, New York, N. Y.
MARY N. TORREY, Bell Telephone Laboratories, New York, N. Y.
Moderator: M. E. KING, Department of the Navy, Bureau of Ordnance, Washington, D. C.

SESSION II E

ELECTRONICS AND AIRCRAFT TECHNICAL COMMITTEES (Sponsors)

"A System for Quality Control in an Electronics Job Shop Operation"
F. J. BERKENKAMP, General Electric Company, Syracuse, N. Y.
Moderator: IRVIN W. SCHOENINGER, Centralab, Milwaukee, Wis.

"Quality Control Budget Methods"
PAUL E. ALLEN, Beech Aircraft Corp., Wichita, Kansas
R. H. STEWART, Lear, Inc., Grand Rapids, Mich.
Moderator: WILLIAM L. COLELLO, Aeroproducts Div., General Motors Corp., Vandalia, Ohio

SESSION II F

GENERAL INTEREST (continued from Monday A.M. Session IF)

"Management of the Quality Control Function" (con't)
A. V. FEIGENBAUM, General Electric Company, Schenectady, N. Y.
W. J. MASSER, General Electric Company, Schenectady, N. Y.
Moderator: F. J. HALTON, JR., Deere and Company, Chicago, Ill.

SESSION II G

APPLIED METHODOLOGY STEERING COMMITTEE (Sponsor)

"Basic Analysis of Variance"
H. B. WAGNER, Rutgers University, New Brunswick, N. J.

"Practical Experimental Designs in Chemical Research"
DONALD S. MacARTHUR, Esso Research and Engineering Co., Linden, N. J.
Moderator: BESSE B. DAY, Department of the Navy, Bureau of Ships, Washington, D. C.

SESSION II H

BASIC CONCEPTS (Education and Training Committee Sponsor)

"Control Chart Analysis of Engineering Experiments"
BONNIE B. SMALL, Western Electric Company, Allentown, Pa.

"How to Use $\bar{X}$ and R Charts Effectively"
HARMON S. BAYER, Consultant, Detroit, Mich.
Moderator: FRANK CAPLAN, JR., General Electric Company, Cincinnati, Ohio

SESSION III TUESDAY A.M.—9:30-11:30—MAY 24, 1955

SESSION III A

METALS TECHNICAL COMMITTEE (Sponsor)

Panel on **"Modification of Statistical Theory and Procedures for Non-Random Distribution of Attributes"**
IRVING W. BURR, Purdue University, Lafayette, Ind.
F. G. NORRIS, Wheeling Steel Corp., Steubenville, Ohio
J. W. W. SULLIVAN, American Iron and Steel Institute, New York, N. Y.
Moderator: ACHESON J. DUNCAN, The Johns Hopkins University, Baltimore, Md.

SESSION III B

CHEMICAL DIVISION (Sponsor)

"Control Charts in Multi-Stage Batch Processes"
RICHARD S. BINGHAM, JR., Atlas Powder Company, Chattanooga, Tenn.

"Use of Quality Control Charts on Continuous Processes"
JOE C. DICKSON, Humble Oil and Refining Co., Baytown, Texas

"Use of Range Charts"
E. C. YEHLE, University of Michigan, Ann Arbor, Mich.
Moderator: WILLIAM J. CHELGREN, E. I. duPont deNemours and Co., Wilmington, Del.

SESSION III C

TEXTILE DIVISION (Sponsor)

"Quality Control—New Technique in the Clothing Industry with a Shortage of Skilled Workers"
R. L. MURRAY, Hardwick Mills, Cleveland, Tenn.

"Visual Grading of Cloth"
GEORGE W. HAYNES, Avondale Mills, Sylacauga, Ala.
Moderator: HERBERT L. WERNER, Werner Textile Consultants, Larchmont, N. Y.

SESSION III D

AUTOMOTIVE STEERING COMMITTEE (Sponsor)

"Machine Tool Capabilities"
BRENT JACOB, JR., Chrysler Corp., Detroit, Mich.

"Quality Control Applied to Plating"
GUY J. CAMPBELL, Ternstedt Div., General Motors Corp., Detroit, Mich.
Moderator: JOHN S. RANDALL, Chevrolet Motor Div., General Motors Corp., Detroit, Mich.

SESSION

APPLIED METHODOLOGY STEERI

"Truncated Distributions"
A. C. COHEN, JR., The Univers

"Examples of Quality Control of
MILTON E. TERRY, Bell Teleph
Moderator: LEONARD A. SEDE

SESSION

ELECTRONICS TECHNICAL COMM

"Redesigning for Production"
HARRY G. ROMIG, International

"Electronic Data Processing"
JOHN D. STEVENSON, Hughes
Moderator: DAVID A. HILL, H
Culver City, Calif.

SESSION

ADMINISTRATIVE APPLICATIONS (Sponsor)

"Statistical Controls Applied to C
WILLIAM F. BUHL, The R. F.

"Statistical Methods Applied to A
JOHN NETER, Syracuse Univers
Moderator: DALE L. LOBSINGE

SESSION

BASIC CONCEPTS (Education and T

"Attributes Theory"
MAX ASTRACHAN, USAF Instit
Air Force Base, Ohio
ANDREW S. SCHULTZ, JR., Co
Moderator: WILLIAM R. PABS
Bureau of Ordnance, Washington

Luncheons—Tuesday P.M.—
TEXTILE DIVISIO
speaker to be

GENERAL LU
Speaker: DR. L. GRANT HECT
Technical Operations, Sonotone
"The Management Yardstick for Measu

SESSION IV TUESDAY P.

SESSION

METALS TECHNICAL COMMITTEE (Sponsors)

"On the Job Controls in a Pipe M
JAMES A. CURRY, Kaiser Steel
Moderator: W. T. ROGERS, Nati
Corp., Lorain, Ohio

"Some Theory of Stratified Sampl
W. EDWARDS DEMING, New Y
Moderator: HAROLD F. DOD
New York, N. Y.

SESSION

CHEMICAL DIVISION (Sponsor)

"Design of Experiments"
SIGURD L. ANDERSEN, E. I.
Wilmington, Del.

"Control Charts in the Petroleum
C. R. HAAG, Esso Standard Oil
Moderator: M. S. RENNER, De
Cambridge, Mass.

SESSION

BREWING INDUSTRY STEERING

"Statistical Quality Control in Be
EVERETT P. HOKANSON, Blatz

"The Use of Statistical Quality C
Malt of Different Suppliers"
FRANK J. ROBERTS, The Strol
Moderator: D. F. SAGER, Arbe

SESSION

AIRCRAFT TECHNICAL COMMITTE

"Vendor Quality Evaluation and C
HENRY C. NEWTON, Bendix R
WILLIAM A. MacCREHAN, JR
Baltimore, Md.
Moderator: JAMES C. McKELV

"Discovery Sampling"
ERVIN F. TAYLOR, North Amer
Moderator: RALPH D. HUMPHI
Wichita, Kansas

SESSION

APPLIED METHODOLOGY STEERI

"Significance Tests by Rank Metho
FRANK W. WILCOXON, Leder
American Cyanamid Co., Pearl

"Multiple Decision Procedures for
ROBERT BECHHOFER, Cornell
Moderator: LLOYD A. KNOWLE
Iowa City, Iowa

RAM

III E

G COMMITTEE (Sponsor)

ty of Georgia, Athens, Ga.
Residuals in Analysis of Variance"
ne Laboratories, Murray Hill, N. J.
R, Consultant, Malden, Mass.

III F

TTEE (Sponsor)

Telemeter Corp., Los Angeles, Calif.

Aircraft Company, Culver City, Calif.
ghes Aircraft Company,

III G

TECHNICAL COMMITTEE

lerical and Accounting Procedures"
Goodrich Co., Akron, Ohio
uditing and Accounting"
lity, Syracuse, N. Y.
R, United Air Lines, Denver, Colo.

III H

raining Committee Sponsor)

ute of Technology, Wright Patterson

nell University, Ithaca, N. Y.
F, JR., Department of the Navy,
, D. C.

-12:15—May 24, 1955
N LUNCHEON
announced
NCHEON
OR, Vice-President in Charge of
Corporation, Elmsford, N. Y.
ring Quality Control Performance"

—2:30-4:00—MAY 24, 1955

IV A

AND TEXTILE DIVISION

ill"
Corp., Fontana, Calif.
onal Tube Div., United States Steel

ng with Applications"
ork University, New York, N. Y.
GE, Bell Telephone Laboratories,

IV B

duPont deNemours and Co.,

Industry"
Company, Linden, N. J.
wey and Almy Chemical Company.

IV C

COMMITTEE (Sponsor)
tling Line Operations"
Brewing Company, Milwaukee, Wis.
ontrol in the Evaluation of the

Brewery Company, Detroit, Mich.
ser-Busch, Inc., St. Louis, Mo.

IV D

E (Sponsor)
ontrol Methods"
lle Division, Baltimore, Md.
, Bendix Radio Division,

AIN, Temco Aircraft, Dallas, Texas

ican Aviation, Inc., Columbus, Ohio
IES, Cessna Aircraft Co.,

IV E

G COMMITTEE (Sponsor)
ds"
e Laboratories, Div.,
River, N. Y.
Ranking Means"
University, Ithaca, N. Y.
R, The State University of Iowa,

SESSION IV F

GENERAL INTEREST
"Quality Control and Its Effect on Supply and Logistics"
BRIGADIER GENERAL WILLIAM P. FARNSWORTH, USAF, Office of the Assistant Secretary of Defense, Washington, D. C.
"The Effect of Quality Control on Standards"
VICE ADMIRAL GEORGE F. HUSSEY, USN (retired), American Standards Association, New York, N. Y.
CYRIL AINSWORTH, American Standards Association, New York, N. Y.
Moderator: MAJOR GENERAL LESLIE E. SIMON, U. S. Army, Office of the Chief of Ordnance, Washington, D. C.

SESSION IV G

ADMINISTRATIVE APPLICATIONS TECHNICAL COMMITTEE (Sponsor)
"Quality Control and Industrial Engineering"
WARREN E. ALBERTS, United Air Lines, Chicago, Ill.
"Market Research Sets Quality Control Targets"
THEODORE H. BROWN, Harvard University, Boston, Mass.
Moderator: HARMON S. BAYER, Consultant, Detroit, Mich.

SESSION IV H

BASIC CONCEPTS (Education and Training Committee Sponsor)
"Reliability of Guided Missiles"
ROBERT LUSSER, Missile Planning and Coordination Office, Redstone Arsenal, Huntsville, Ala.
"Testing One Million Transistors"
GEORGE R. SCHEEL, Sonotone Corporation, White Plains, N. Y.
WILLIAM H. GREENBAUM, Sonotone Corporation, Elmsford, N. Y.
Moderator: JOHN W. ENELL, American Management Association, New York, N. Y.

SESSION V WEDNESDAY A.M.—9:25-11:25—MAY 25, 1955

SESSION V A

METALS TECHNICAL COMMITTEE (Sponsor)
"Specific Examples of Broad Interest of the Application of Regression Analysis in the Metal Industry"
DONALD S. LECKIE, Republic Steel Corp., Cleveland, Ohio
Moderator: HAROLD SPRINGER, St. Joseph Lead Co., Monaca, Pa.
"Specific Examples of Broad Interest of the Application of Analysis of Variance in the Metal Industry"
JOHN D. HROMI, United States Steel Corp., Pittsburgh, Pa.
Moderator: P. R. BRUCKER, Crucible Steel Co. of America, Midland, Pa.

SESSION V B

PAPER SUBCOMMITTEE OF THE CHEMICAL DIVISION (Sponsor)
"Competitive Quality—Mountain or Molehill"
ROBERT H. LACE, Riverside Paper Corp., Appleton, Wis.
Panel on: **"Paper and Graphic Arts Quality Problems"**
Moderator: RICHARD S. BINGHAM, JR., Atlas Powder Company, Chattanooga, Tenn.

SESSION V C

TEXTILE DIVISION (Sponsor)
"Control Chart Applications in Textiles"
NORBERT L. ENRICK, Institute of Textile Technology, Charlottesville, Va.
"Linear Programming"
HARRY T. SCHWAN, Methods Engineering Council, Pittsburgh, Pa.
Moderator: C. W. CARTER, Rath and Strong, Boston, Mass.

SESSION V D

ELECTRONICS TECHNICAL COMMITTEE (Sopnsor)
"Applications of Statistical Methods in Evaluating Performance of Electronic Equipment"
RALPH L. MADISON, Aeronautical Radio, Inc., Washington, D. C.
"Problems of Selective Assembly"
R. B. MURPHY, Bell Telephone Laboratories, New York, N. Y.
Moderator: LEO J. JACOBSON, International Resistance Co., Philadelphia, Pa.

SESSION V E

AIRCRAFT TECHNICAL COMMITTEE (Sponsor)
"Advantages and Applications of Statistical Quality Control in the Aircraft Industry"
J. L. COBURN, Convair, Fort Worth, Texas
Moderator: H. B. EPSTEIN, Chance Vought Aircraft, Dallas, Texas
"Effects on Military Contractors of Difference Between Air Force and Navy Quality Control Policy"
CAPT. R. F. MAHACEK, U.S. Navy, Bureau of Aeronautics, Washington, D. C.
COL. C. A. PETERSON, AMC, Wright Patterson Air Force Base, Ohio
Moderator: J. Y. McCLURE, Convair, Fort Worth, Texas

SESSION V F

SUBCOMMITTEE ON FOOD INDUSTRIES APPLICATIONS (Chemical Division Sponsor)
"Quality Control Techniques Used in the Food Industry"
FLOYD J. HOSKING, Corn Industries Research Foundation, Inc., Washington, D. C.
"Fill Control in the Canning Industry"
C. B. WAY, Green Giant Company, Leisueur, Minn.
"A Modified Lot Plot Sampling Procedure for Controlling Container Fill"
LEONARD F. GIESEKER, National Can Company, Baltimore, Md.
Moderator: OWEN F. KEELER, JR., John I. Thompson and Co., Washington, D. C.

SESSION V G

APPLIED METHODOLOGY STEERING COMMITTEE (Sponsor)
"Problems of Multiple Comparisons with a Standard"
CHARLES W. DUNNETT, Lederle Laboratories Div., American Cyanamid Co., Pearl River, N. Y.
"Experiences in a Pharmaceutical Research Laboratory"
WILLIAM S. CONNOR, Johnson and Johnson, New Brunswick, N. J.
Moderator: SEBASTIAN B. LITTAUER, Columbia University, New York, N. Y.

SESSION V H

OPERATIONS RESEARCH COMMITTEE (Sponsor)
"Design for Decision"
IRWIN D. J. BROSS, Cornell University Medical School, New York, N. Y.
"Integrating O.R. into a Business"
HARLAN D. MILLS, General Electric Company, New York, N. Y.
Moderator: PAUL S. OLMSTEAD, Bell Telephone Laboratories, Whippany, N. J.

Luncheons—Wednesday P.M.—12:15—May 25, 1955
METALS TECHNICAL COMMITTEE LUNCHEON
Speaker: DR. RALPH C. HUTCHISON, President, Lafayette College, Easton, Pa.
"Human Freedom and Foreign Policy"
GENERAL LUNCHEON
Speaker: DR. MASON W. GROSS, Provost, Rutgers University, The State University of New Jersey, New Brunswick, N. J.
"Quality and Quantity in Higher Education"

SESSION VI WEDNESDAY P.M.—2:00-4:00—MAY 25, 1955

SESSION VI A

SUBCOMMITTEE ON FOOD INDUSTRIES APPLICATIONS (Chemical Division Sponsor)
Taste Testing Panel
"Rating Scales and Psychological Factors"
JAMES A. BAYTON, Howard University, Washington, D. C.
"Use in New Product Development"
GWENETH HEDLUND, General Mills, Inc., Minneapolis, Minn.
"Statistical Designs and Analysis"
RALPH A. BRADLEY, Rutgers University, New Brunswick, N. J., and Virginia Polytechnic Institute, Blacksburg, Va.
Moderator: H. L. STIER, National Canners Association, Washington, D. C.

SESSION VI B

ADMINISTRATIVE APPLICATIONS TECHNICAL COMMITTEE (Sponsor)
"Methods Improvement Through Quality Techniques"
BLAIR E. OLMSTEAD, The Prudential Insurance Company of America, Newark, N. J.
Moderator: HOWARD L. JONES, Illinois Bell Telephone Co., Chicago, Ill.
GENERAL INTEREST
"Statistical Technique for Adjusting Production to Sales Trends"
E. H. ROBINSON, Johnson and Johnson, Chicago, Ill.
Moderator: F. BRUCE MAY, Johnson and Johnson, New Brunswick, N. J.

SESSION VI C

APPLIED METHODOLOGY STEERING COMMITTEE (Sponsor)
"The Purpose and Meaning of Control Charts"
C. C. CRAIG, University of Michigan, Ann Arbor, Mich.
"The Nature of the Standard Control Chart, and Some of Its Competitors"
EDWIN G. OLDS, Carnegie Institute of Technology, Pittsburgh, Pa.
Moderator: WALTER A. SHEWHART, Bell Telephone Laboratories, Murray Hill, N. J.

SESSION VI D

BASIC CONCEPTS (Education and Training Committee Sponsor)
"Acceptance Sampling"
G. W. McELRATH, University of Minnesota, Minneapolis, Minn.
"Criteria for Selection of an Attribute Sampling Inspection Plan"
HERBERT ARKIN, College of the City of New York, New York, N.Y.
Moderator: JOSEPH MOVSHIN, Ramsey Corporation, St. Louis, Mo.

SESSION VI E

GENERAL INTEREST
Panel on: **"Reaching the Worker and Industrial Communication"**
WILLIAM P. GOEPFERT, Aluminum Company of America, Pittsburgh, Pa.
WILLIAM GOMBERG, International Ladies' Garment Workers Union, New York, N. Y.
H. E. THOMPSON, Anaconda Wire and Cable Company, Hastings-on-Hudson, N. Y.
Moderator: SIMON COLLIER, Johns-Manville Corp., New York, N. Y.

SESSION VI F

AUTOMOTIVE STEERING COMMITTEE (Sponsor)
"Industrial Engineering and Quality Control"
GEORGE BLUTH, Studebaker-Packard Corp., Detroit, Mich.
"Control of Torque"
CHARLES QUILLEN, Ford Motor Co., Dearborn, Mich.
Moderator: J. CLAYTON KNAPP, Ford Motor Co. of Canada, Ltd., Windsor, Ontario, Canada

lot which is approved by attaining a palatability rating higher than its "true" rating, though inferior, is still usable—an assumption which is probably right in almost all cases. The true risk, that is the risk of accepting a lot of such poor quality that the candy would detract seriously from the value of the ration in which used, is unknown but is believed to be slight.

In using this control chart method the variability within the set of judgments from a single panel was disregarded, except insofar as it might have contributed to the variability among the palatability ratings of the group of samples used to establish the standard. This was a logical defect and it later became evident that it could have serious practical consequences, hence it was discarded in favor of a method which takes the intra-panel variability into account. The standard palatability score is normally based on tests of at least seven samples, making a total of from 105 to 140 judgments, hence will be quite stable. However, the standard error of the palatability rating is derived from a single 20-judgment test and is significantly large. In the procedure now used the standard score is considered as a fixed criterion and the control limit is calculated separately for each sample, being set at two standard errors of the sample mean below the standard score.

Figure 4 is the control chart for another special type of candy. The standard palatability score is the same as for Type A but the variability is less, and a tighter control limit results. This suggests the possibility of establishing a single palatability control standard for all types of candy. However, our results so far have not demonstrated the advisability of such an attempt. The control charts for many types of candy are similar to the two shown, but there are sufficient differences in both standard scores and variability to make the value of a single standard questionable. Determination of what types of candy should be included in the rations is a consumer preference problem, and not one to be solved during the control testing. The direct objective, and the only justifiable one for such small-panel testing, is to determine relative palatability within a restricted range.

FLAVOR IDENTITY CONTROL

The palatability rating method has been used for a number of products besides candy, including soluble coffee, soluble tea, chewing gum, dehydrated pea soup, and imitation maple sirup. Another control problem in connection with the latter product arises in the additional specification requirement that the sirup ". . . shall have a flavor similar to that of genuine maple sirup." The flavor itself becames a subjective standard and testing is done by the simple flavor identification test, already described. The panel member tastes one sample at a time and answers the question. "Does it taste like maple?" with a simple "Yes" or "No." The test result, or flavor identity score, is the percentage of positive identifications made by a panel of 15 to 20 persons. Control limits for this characteristic were established on a different basis than for candy palatability. Preaward samples received from the bidders varied so widely that their average flavor identity score was not a suitable standard. An arbitrary standard was not valid because of the unpredictable panel error which results in negative responses even with the best sirup. The solution was to test various commercial sirups that were considered technologically "good." The distribution of their flavor identity scores provided measures of both average achievement and variability within good commercial practice—measures which were adjusted for panel error. When preaward samples are evaluated one or more of these standard sirups are included in the test to provide for continuity of the standard. The control chart for maple flavor identity is shown in Fig. 5. The flavor identity score for the standard sirups is 82 percent and the 2σ limit falls at 69 percent. Note the great variation among the preaward samples. This variation is so

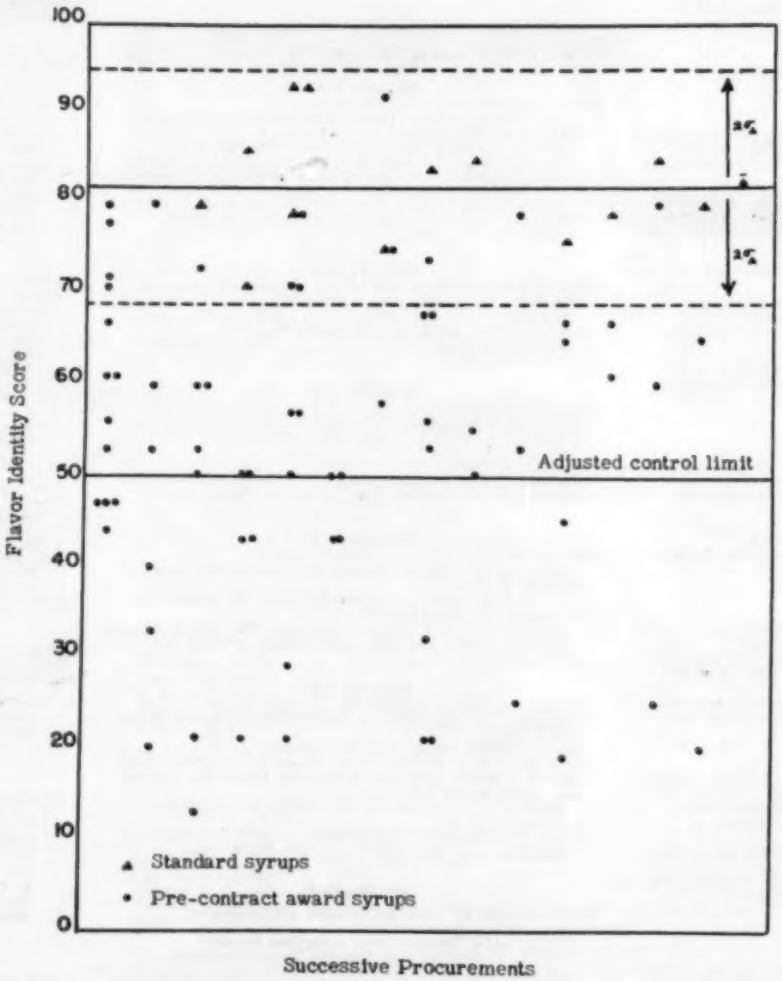


Figure 5—Control Chart for Flavor Identity Scores of Imitation Maple Sirup

large that it has nullified the neat statistics of the control procedure. The 69 percent limit was found to be impractical since it would have excluded too many bidders so the control limit was arbitrarily adjusted downward to 50 percent, which is actually 4.9 σ's below the standard score.

SUMMARY

Three objectives guided the development of this paper. First, to gain acceptance of the idea that effective flavor quality control requires use of human observers; second, to show how the human response can give reliable information about flavor variables through use of the proper test methods; third, to make these points more convincing by demonstrating the use of adequate methods in flavor control. It is our belief that, through intelligent selection and application of such techniques, food processors will be able to reap the benefits of using statistical methods to control flavor quality and consumer acceptance of their products.

References

1. Kramer, Amihud, "Quality Control Simplified," *Food Engineering*, Vol. 24, No. 12, 1952.
2. Peryam, David R., "Quality Control in the Production of Blended Whiskey," *Industrial Quality Control*, Vol. VII, No. 3, Nov. 1950, p. 17.
3. Peryam, David R. and Girardot, Norman F., "Advanced Taste Test Method," *Food Engineering*, Vol. 24, No. 7, 1952.
4. Peryam, David R. and Swartz, VeNona, "Measurement of Sensory Differences," *Food Technology*, Vol. 5, 1951.

Bibliography

JOSEPH MOVSHIN, *Editor*
Assisted by the Editorial Committee, St. Louis Section, ASQC

On matters concerning the Bibliography Department, send correspondence, suggestions, and contributions to:
Joseph Movshin
9220 Old Bonhomme Road
St. Louis 24, Mo.

APPLICATION—MISCELLANEOUS

STATISTICAL CONTROL METHODS AND WHITEWARE INDUSTRY, by J. H. Simcock
(Transactions British Ceramic Society—v. 53, n. 11, Nov. 1954, p. 764)

This article describes some of the basic techniques of statistical quality control. The use of small samples in variability control and the construction of the "Shewhart" control chart are described. Calculation of standard deviation is included. The use and interpretation of control charts is presented.

THE MACRO-ETCH SYSTEM OF EVALUATING QUALITY OF RESISTANCE WELDING, by D. O. Samuelson, Welding Engineer, and F. G. Harkins, Chief Welding Engineer, both of Solar Aircraft Co.
(The Welding Journal—v. 34, n. 2, Feb. 1955, p. 105)

In an effort to reduce the cost of quality control procedures for resistance welding of aircraft structures, an analysis of nugget size and quality in relation to tensile strength was made. This article covers the analysis and the conclusions. Illustrated with numerous pictures and charts.

CONTROL CHARTS

QUALITY CONTROL IN WIRE INDUSTRY, by A. U. Sternlof
(Wire & Wire Products—v. 29, n. 11, Nov. 1954, p. 1315)

This article compares the use of modified and "total spread" methods with conventional three sigma control limits. This is considered particularly in terms of the job shop and short run installation where the process control must be established immediately on the basis of the specification. The advantages are illustrated in terms of the dimensions and resistances of coated copper wire.

ENGINEERING & EXPERIMENTS

STATISTICAL ANALYSIS AIDS PROCESS CONTROL, by Edwin M. Bartee, Industrial Engineer, Reynolds Alloys Co., Sheffield, Ala.
(The Journal of Industrial Engineering—v. VI, n. 1, Jan. 1955, p. 16)

Statistically, it is possible to determine what variables are significantly important in a process. It is then possible to control those of maximum importance and thereby the whole process. Measurements of variation and deviation are necessary to know the capability of a process. Examples of the development of such measurements in a structural mill are given. The use of control charts and procedure for obtaining the data are described.

Selected references in the Bibliography of *Industrial Quality Control* are obtained from the following sources:

The International Statistical Institute, *International Journal of Abstracts on Statistical Methods in Industry.*

MANAGEMENT & PERSONNEL, GENERAL

CLOSE TOLERANCES COST LESS, by Emil F. Gibian, Thompson Products Inc.
(Production—v. 35, n. 2, Feb. 1955, p. 55)

Very brief comments on the value of statistical quality control and its relation to new trends in automation.

A GAGEMAKER'S CONCEPT OF QUALITY CONTROL, by C. V. Briner, Manager, Gage Division, The Pipe Machinery Co.
(Tooling and Production—v. 20, n. 7, Oct. 1954)

The direct application of attitude and feeling of employees is the key to quality control in this company that makes gaging equipment. The establishment of definite responsibilities is an important factor in this program.

"EXCESS REJECTS" SPOT PROCESS TROUBLES, by S. Winchell

(American Machinist—v. 98, n. 21, Oct. 11, 1954, p. 142)

Warner & Swasey Co., Cleveland, describe their approach to in-process quality control in teams as "Excess Reject System." Basically the cooperation of machine operator, foreman, and inspector are stressed to immediately find sources of excessive rejects and correct such trouble before it has progressed too far. The cooperative endeavor established is credited with scrap reduction and product quality improvement.

THE ADMINISTRATION OF OPERATIONS RESEARCH, by J. W. Pocock, Partner, Booz, Allen & Hamilton

(Advanced Management—v. XX, n. 2, Feb. 1955, p. 10)

The problem of whether or not operations research groups should be new and separate sections of an organization or integrated into established staff organizations is discussed in some detail. The problem of education, training and of establishing confidence in this group is discussed. The need for top management to understand and to be able to follow operations research programs is indicated.

PLACE AND COST OF OPERATIONS RESEARCH IN YOUR COMPANY, by Dr. Ellis A. Johnson, Director, Operation Research Office, Johns Hopkins University

(Advanced Management—v. XX, n. 1, Jan. 1955, p. 9)

Operations research is presented as a new approach to the problems of industry rather than a series of new techniques. Operations research is described as "a new kind of exploring which can present to management a great deal of the information needed to arrive at decisions". The article further stresses the fact that new personnel are not necessarily required but that existing personnel, for example industrial engineers, can set up and follow such studies. The questions of costs in various size programs are discussed.

INDUSTRIAL MANAGEMENT

HOW MANY TIME STUDY READINGS TO TAKE, by Gerald Nadler, Washington University, St. Louis, Mo.

(Factory Management & Maintenance—v. 113, n. 2, Feb. 1955, p. 132)

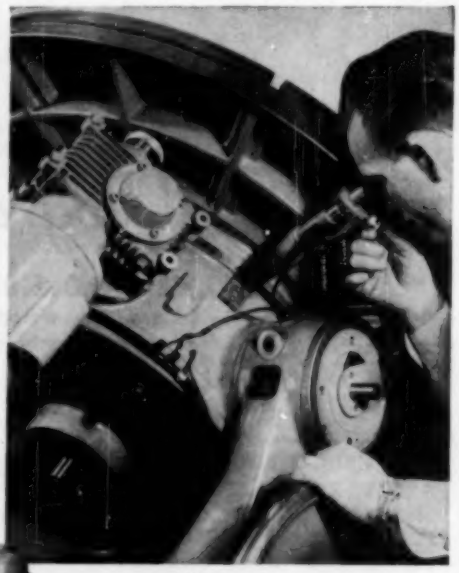
Based on statistics, and probability, this nomograph shows how to find the correct number of readings to take on each element of a time study for a given risk. Easy to use, it will also spot unreliable time values.

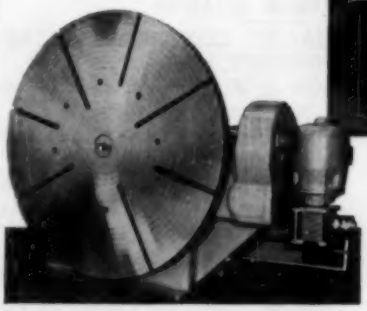
MISCELLANEOUS

MASTER GAGING, by B. M. Hall (Production—v. 35, n. 2, Feb. 1955, p. 53)

Brief description of some of the Work done in the Detroit Arsenal

Industry's First High-Precision Universal Inspection Table





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HOW MAGNETIC TESTING HELPS MAINTAIN YOUR QUALITY STANDARDS, by Gerald T. Barta, Quality Control Manager, The Indiana Steel Products Co.
(Applied Magnetics—v. 2, n. 5, Sept. 1954, p. 2)

This article describes the theory of magnetic tests of material. Some of the tests performed and the methods of performing and analyzing these tests.

SAMPLING PLANS & RELATED TOPICS

SAMPLING PLANS REDUCE INSPECTION TIME, by H. H. Saltz
(Tool Engineer—v. 33, n. 3, Sept. 1954, p. 45)

Sampling inspection by attributes and by variables are compared. Some discussion is presented on the factors to be considered in selecting an appropriate sampling plan. Procedures for using sampling plans as well as the advantages of both attribute and variable sampling are given. Tables and charts included.

A PHILOSOPHY OF INSPECTION
(Welders' Digest—Jan. 1955, p. 19)

A very brief consideration of the effects of a sample inspection of welds of critical areas of ships. A brief discussion of the probability aspect of protection versus the psychological in this case are presented.

CONTINUOUS SAMPLING INSPECTION — KEY TO THIS COMPANY'S MASS PRODUCTION, by Alan L. MacLean, Minneapolis-Honeywell Regulator Co.
(Factory Management & Maintenance—v. 113, n. 2, Feb. 1955, p. 114)

Tells how assembly lines for thermostats were built around continuous sampling. Results: Increased production, lower costs, 80% improvement in quality. Illustrated with pictures and charts.

STATISTICS

CONTROL CHARTS FOR THE MEAN OF A NORMAL POPULATION, by E. S. Page
(Royal Statistical Society Journal —v. 16, n. 1, 1954, p. 131)

APPLICATION OF AUTOMATIC COMPUTERS TO SAMPLING EXPERIMENTS, by K. D. Tocher
(Royal Statistical Society Journal —v. 16, n. 1, 1954, p. 39)

ERRORS OF LATTICE SAMPLING, by H. D. Patterson
(Royal Statistical Society Journal —v. 16, n. 1, 1954, p. 140)

IMPROVEMENT TO WALD'S APPROXIMATION FOR SOME PROPERTIES OF SEQUENTIAL TESTS, by E. S. Page
(Royal Statistical Society Journal —v. 16, n. 1, 1954, p. 136)

POOR MAN'S MONTE CARLO, by J. M. Hammersley
(Royal Statistical Society Journal —v. 16, n. 1, 1954, p. 23)

INSPECTION — ITS RELATION TO OPERATIONAL RESEARCH, by E. D. Van Rest
(Operational Research Quarterly —v. 5, Sept. 1954, p. 60)

PROBABILITY MODELS IN BIOLOGY AND ENGINEERING, by Samuel Goldberg
(Journal of the Society for Industrial and Applied Mathematics—v. 2, n. 1, Mar. 1954, p. 10)

OPERATIONS RESEARCH

MILITARY DECISION AND GAME THEORY, by O. G. Haywood, Jr.

TRAINING FOR OPERATIONS RESEARCH, by Joseph F. McCloskey

SOLUTION OF A LARGE-SCALE TRAVELING-SALESMAN PROBLEM, by G. Dantzig, R. Fulkerson and S. Johnson

INDUSTRIAL ECONOMICS AND OPERATIONS RESEARCH AT STANFORD RESEARCH INSTITUTE, by William J. Platt

OPTIMUM OPERATION OF A COMPLEX ACTIVITY UNDER CONDITIONS OF UNCERTAINTY, by Morris J. Solomon

NUMERICAL SOLUTION OF THE PROBLEM OF OPTIMUM DISTRIBUTION OF EFFORT, by William Miehle

This issue also contains an index for volume 2.
(Journal of the Operations Research Society of America—v. 2, n. 4, Nov. 1954)

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Local Section News

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ALBUQUERQUE Dr. Bennett L. Basore, Sandia Corp., reviewed a paper on "Statistical Theory of Radar Detection" before a joint meeting of the Albuquerque Section of ASQC and the IRE Professional Group on Information Theory. The meeting was held at the University of New Mexico on Jan. 12.

James R. Duffett, Head of the Reliability Section, Systems Analysis Branch of the Ordnance Mission, White Sands Proving Ground, spoke on "Statistical Considerations in Measurements" at the Feb. 25 meeting held at the University of New Mexico.

ALLENTOWN-BETHLEHEM This section was greatly impressed by the splendid talk on quality control by Dale Lobsinger of United Air Lines at their February meeting. The simplicity and effectiveness of his program for quality control (better named "Money in the Bank") was astonishing and encouraging. His application to airline operations proved again that versatility is inherent in quality control.

BALTIMORE M. H. Replogle, Davison Chemical Co., kept the members attending the March 16 meeting thoroughly entertained by his effective presentation during his talk, "Laboratory Tests and Statistical Techniques".

The discussion period was led by Dr. A. J. Duncan and much spirited comment was made on the various methods to analyze data. As the section has many members who use analytical techniques in their daily work, the scope of discussion covered planned experimentation, correlation and grouped control charts.

Each year, Dr. A. J. Duncan has guided various members of the Baltimore Section through some form of an educational program. This year, with the assistance of other members an advanced course in "Correlation and Design of Experiment" was conducted in a series of three evening meetings spaced a month apart. Thirty-four members faithfully followed the mathematical gyrations of the elusive sigma to earn a "well done" from Dr. Duncan.

CLEVELAND The regular monthly meeting of the Cleveland Section was held on Feb. 4. Mr. Ralph E. Burt, founder and head of the National "U" Association was the speaker of the evening. He gave a very enlightening talk on "Human Relations and Quality Control."

DAYTON The regular monthly meeting of the Dayton Section for February was held on Feb. 17 at Annarino's in the form of a dinner meeting. The speaker for this meeting was Leon Bass of the G. E. Jet Engine Dept., who talked on "The Advantages of the Use of Statistical Methods." The section had a nice turnout of members as well as several guests attending this meeting.

"An Informal Discussion of Advanced Techniques in Statistical Quality Control" was held on Mar. 3 at the Standard Register Co. A panel of prominent members of the section discussed tests of significance, correlation and other advanced techniques. This meeting was promoted by the Educational Committee with the idea of organizing educational activity along these lines.

ERIE Donald E. Frank, Erie General Electric, presented a program entitled "The Evaluation of Quality Control Personnel By Means of Psychological Testing" at our Feb. 9 meeting at Hotel Kenyon. The correlation between the opinions of quality control supervision concerning inspectors and the inspectors test scores was most impressive.

GEORGIA The second meeting of the Atlanta Group was attended by 19 persons, eager to learn more about the application of statistical analysis. Some may have come because of the reputation of the speaker as a teacher. Donald S. Holmes, Georgia Institute of Technology, Atlanta, presented an illustrated talk on "Application of Game Theory to Quality Control." It was an excellent presentation that stimulated the thinking of all persons present, and set a high level of quality as a goal for future speakers.

The Middle Georgia Group of the Georgia Section was recently formed to render improved service to members in the Macon area. The first monthly meeting of this group was held in the Kilowatt Room of the Georgia Power Co., Macon. The speaker of the evening was George Lucas, Warner Robins Air Materiel Area, who spoke on the subject "Precision Instruments." Presiding over the meeting was George Calver, recently elected chairman of the group.

HUNTSVILLE On Feb. 17 the Huntsville Section held its annual clinic night in the Longfellow Room of the Huntsville Public Library. Mr. Mathew Weber, chief chemical engineer at Thiokol Chemical Corp., was the moderator. Members of the local section were asked to submit problems for group discussion. Of the total number submitted, three were selected for discussion. These included a problem in sampling, calculation of operating characteristic curves, and a problem in establishing a basis for calculating control limits.

INDIANAPOLIS On Feb. 15 at 4:30 p.m., the Indianapolis Section opened the monthly meeting day with an address by Charles Hicks, Purdue University. He spoke on "An Introduction to Operations Research." At 7:30 p.m., the Indianapolis Section was addressed by a former member and officer, Dale Cue, A. O. Smith Corp., Milwaukee, Wis. His subject was "Not Quite Statistical Sampling." This evening meeting was billed as "Ladies' Night." As special entertainment, Dr. I. W. Burr, Purdue University, gave a short, entertaining talk which he directed to the ladies.

INDIANAPOLIS
Columbus Sub-Section The Columbus Sub-Section held a dinner meeting on Feb. 10. The speaker was Arthur Bender, Jr., Delco-Remy Div., GMC. His subject was "Fundamentals of Quality Control."

INDIANAPOLIS
Lafayette Sub-Section On Feb. 23 this group was addressed by Prof. Charles Hicks, Purdue University. His subject was "The Fundamentals of Acceptance Sampling."

KANSAS CITY The February dinner meeting at the Blue Hills Restaurant was attended by some 40 members and guests. After the business meeting, a panel discussion was held on "Quality Control at Work." The panel, with William Hook, Air Force Inspection, as moderator, consisted of Ed Walske, Colgate-Palmolive Co., Frank Porter, Westinghouse Electric Corp., A.G.F. Division; William Robinson, General Motors Corp., B.O.P. Aircraft Div., and Hugh Springer, Sheffield Steel Corp.

LINCOLN The February meeting of the Lincoln Section was held at the Cornhusker Ordnance Plant with the Silas Masm Co. as host. The program—"Use of Vital Aids in Quality Control."

LOS ANGELES James B. Buehler, North American Aviation Corp., spoke before the February meeting of the Los Angeles Section on "Selling Quality Control to the Vendor." With the slogan that a good vendor is one who has an effective quality control system, an active vendor certification program, and accepts assistance by Company QC engineers the incoming material problems at North American has been materially reduced.

LOUISVILLE The annual Management Night dinner meeting was held Feb. 17. Arthur Dagle, Ford Motor Co., spoke to the group on the quality control program at Ford. His talk was extremely interesting and informative. Many questions were asked the speaker at the question session following his address.

MICHIGAN Broadway came to the Michigan Section this month in the "form" of an entertaining personality from the Bronx, Dr. William Gomberg of the International Ladies' Garment Workers Union. The doctor "stretched" a few points here and there to "cover" what he did of his subject "How the Union Looks at Quality Control." The speaker sewed a fine thread of anticipation to hold his audience as they did not know what would "give" next from the Ladies' Garment Workers Representative.

MILWAUKEE The Feb. 21 meeting of the Milwaukee Section began at 12:45 p.m. with a tour of the International Harvester plant. B. F. Litzau and G. Ceragioli were the hosts and conducted the group on an excellent tour. Although International Harvester's QC program has many phases none was more outstanding than their foundry application. After an informal supper at Marquette Union, the group reconvened at 7:30 for the evening meeting in the Business Administration Bldg. The speaker of the evening was W. E. Spencer, Allison Div., GMC, who gave a slide-illustrated talk on Allison's QC applications.

As a special feature of the meeting Paul A. Robert, president of ASQC, presented a leather-bound copy of the Board of Directors' Resolution to Mrs. R. S. Saddoris, who was our guest for the evening. Also on hand for the presentation ceremony were the Henry J. Beckers, the Fred Haltons and the E. H. Robinsons.

MINNESOTA A. V. Feigenbaum, manager of quality control and cost reduction for the General Electric Co., Schenectady, was the speaker at the regular meeting of the Minnesota Section on Thursday, Feb. 24. The topic of Dr. Feigenbaum's talk was "Quality Control as a Management Method" and proved highly interesting to the large group present.

MUNCIE The meeting of Feb. 17 was held in the L. A. Pettinger Student Center, Ball State Teachers College. Mr. Cecil Brown, inspection supervisor at the A-C Spark Plug Div., GMC, talked on the subject of multiple sampling to fit the job.

NEW HAVEN On Feb. 8 the section held a very successful clinic session on the following subjects: (1) Tolerances & Process Capability. (2) Acceptance Sampling. (3) Visual Standards. (4) Attribute Control. An old-fashioned church supper was enjoyed by all prior to the regular meeting and clinic groups. Similar clinic sessions are planned for next season, based on the enthusiastic response at this meeting.

RICHMOND The talk on Feb. 22 by James R. Thomen, duPont film division, on "Statistical Applications to Time Study" provoked a very interesting discussion particularly since a few of the section members had brought to the meeting some of their company's industrial engineers. The paper was recently written as a doctorate dissertation at Columbia University, which from what we heard of it will insure Jim a "Dr." before his name before long.

ST. LOUIS Due to the untimely death of our President, Ray Saddoris, several changes were made in our February meeting. Since Ray's talk was published in the January issue of IQC the local section changed their plan of meeting and instead of having the talk given as announced in the February issue a "Forms Forum" was instituted. This proved to be a most educational meeting in which seven different company representatives presented the various quality control forms used in their respective companies. A great amount of interest was shown by all those who attended and it is felt that other sections might profit much by having such a meeting scheduled for the coming year.

The section held a Spring training course as a follow-up to the Fall basic course; entitled, "An Intermediate Course in Quality Control (Special Application)." The course was offered to stress the application of statistical quality control in industry. The subjects discussed were as follows: 1. Administration of Sampling Plans. 2. Use of Normal Distributions in Setting Specifications. 3. Multiple Characteristic Control Charts. 4. Control Charts and Control Methods on Multiple Spindle and Multiple Cavity Operations. 5. Continuous Production Inspection Methods—Process Industries. 7. Handling of Skewed Distributions in Variables. 8. Quality Control Forms. Members of the local section served as instructors and included the following: Movshin, Von Meyer, Whyte, Leatherman, Vezeau and

Braun. Eighteen local QC enthusiasts signed up for the course and it has been most interesting and instructive to everyone concerned.

SCRANTON—WILKES-BARRE Dr. Stephen Malaker, coordinator of nuclear products at Daystrom Instument Div., spoke at the Jan. 27 meeting. Speaking on the subject "Applications of Nuclear Energy in Statistical Quality Control," he discussed some of the newer applications of nuclear instruments and techniques to quality control of in-process compliments.

A joint meeting of the Scranton-Wilkes-Barre Section and the Keystone Chapter of the ASTE was held at the Scranton Chamber of Commerce Bldg. on Feb. 23. An exhibition and lecture on **Civilization Through Tools** was given by C. G. Schelley, Managing Director of the Wilkie Foundation. He traced the evolution and development of tools over a one million year span, from primitive to modern times, providing a very interesting evening.

As a result of section sponsorship, Penn State University Extension has been giving elementary and advanced courses in statistical quality control since 1953. Approximately 60 people from various industries have taken these courses. Carl Larsen, past section chairman, has been the instructor. L. E. Daniels also served as instructor for the second elementary course.

SEATTLE Over 65 members and guests turned out to an "S.R.O." meeting Feb. 8 to hear the popular Dr. Carl A. Bennett, mathematical statistician, General Electric Co., Richland, Wash., speak on the subject "Recent Advances in the Design and Analysis of Industrial Experiments."

SOUTH BEND—MISHAWAKA The Ladies' Nite Dinner on Feb. 17 was the most successful meeting of this section to date. Frank McQuire of Linde Air Products described the process for the synthesis of jewels, traced the growth of the industry in the United States during and after World War II, and demonstrated some of the commercial applications of this fascinating product. A door prize was awarded, courtesy of Linde Air Products.

SOUTHERN CONNECTICUT The staff director of industrial engineering for Thompson Products, Inc., E. F. Gibian, was guest speaker at the Feb. 9 meeting of the Southern Connecticut Section. Dinner was at 6:45 p.m. with the main meeting getting underway promptly at 8:00 o'clock. Mr. Gibian's topic was "Engineering Applications of Statistical Quality Control" which was well received. Several actual case histories were used by Mr. Gibian to illustrate how his company handled engineering applications of statistical quality control. A lively question and answer period followed the discussion in which Dorian Shainin, vice president of ASQC, who was a visitor at the meeting, took part.

As a member of the Connecticut Technical Council, the Southern Connecticut Section, participated in National Engineers Week, Feb. 20-26. The Connecticut program came to a successful conclusion with the banquet at the Barnum Hotel, Bridgeport, on Feb. 26. The symposium program this year was conducted by the Connecticut Society of Professional Engineers. The citation given by the CSPE for Engineer of the Year from the State of Connecticut reads—"In recognition for Outstanding Service in the Practical Application of Engineering Talent." This annual award was presented for the first time at the banquet for engineering accomplishments during the year 1954. It is the highest award given to engineers in Connecticut and the recipient is not limited to any particular branch of engineering or field of endeavor. Selection of the engineer to receive this award was made by the awards committee of the Connecticut Technical Council and the CSPE, under the chairmanship of Dr. W. P. Berggren, Director of Engineering at the University of Bridgeport.

SOUTHERN TIER A total of 48 members and guests attended the monthly dinner meeting of the Southern Tier Section at the Vestal American Legion Clubhouse. The guest speaker was O. H. Somers, superintendent quality control engineering, Aims and Ammunition Div., Olin Mathieson Chemical Corp., New Haven. Mr. Somers' subject was "Engineering for Quality" which included four case histories of problems which were solved by a combination of engineering and statistical methods.

STATE UNIVERSITY OF IOWA Bob Wright, president of the University of Iowa Section, was the speaker at the Feb. 17 meeting of the Quint-City group. Mr. Wright presented an interesting discussion on sampling plans and illustrated the talk with several charts.

SYRACUSE Maynard S. Renner, staff assistant for quality to the vice president of research of the Dewey & Almy Chemical Co., Cambridge, Mass., spoke on "The Role of Statistical Quality Control in Today's Chemical Company" before the section meeting on Feb. 22. His talk was a very stimulating one as was indicated by the numerous questions which were asked afterwards.

TOLEDO The Toledo Section was fortunate in obtaining John Harrington of the DoALL Co. for the speaker at its Feb. 17 meeting. Mr. Harrington gave a very interesting talk on the science of precision measurement. He attracted one of our largest turnouts of the season. Jack B. Schneider, Toledo Stamping & Mfg. Co., was the chairman for the meeting.

TORONTO On Feb. 9 R. W. Glenfield of Dominion Rubber Co., Kitchener, Ont., gave a comprehensive outline of the quality control methods used in his plant. He also explained the development of quality control as applied to the manufacture of automobile tires. This very interesting presentation was well illustrated with colored slides.

TRENTON At its Jan. 7 meeting Allan C. Crawford, Rutgers University, addressed the Trenton Section on the subject "Design of Experiments."

Leo Jacobson, International Resistance Co., spoke on machine capabilities at the Feb. 4 meeting. Following the meeting a social get-together with beer and pretzels was held for the members and guests.

WASHINGTON Approximately 30 members of the section were present at the meeting on Feb. 23 to hear a panel discussion on "Design of Experiments." The panel consisted of Charles A. Bicking, Department of Defense; W. J. Youden, Na-

Toledo Section display as it appeared in the window of the Ohio Bell Telephone Co. during the observance of National Engineers Week, Feb. 20—Feb. 27.

tional Bureau of Standards, and Besse B. Day, U. S. Naval Engineering Experiment Station.

On that same night prior to the meeting the section started its "Quality Control Course." Thirty-seven prospective students were present. The first lecture was given by Mr. Weingarten. Other instructors are Mr. C. Bicking, M. King, and S. Lorber.

WESTERN MASSACHUSETTS Western Massachusetts had another first in that on Feb. 24, 1955, 74 people, representing 38 companies in this area, attended an all-day Workshop on Experimental Design and Analysis. The course was given at the Western New England College and the instructors were C. D. Ferris, E. C. Harrington and J. D. Hinchen. The fee for the entire day, including the luncheon and lecture notes was $5.00. Even at this the section was able to earn some money and still supply a service to the quality control people in the area.

WICHITA The Wichita Section met for its regular dinner meeting at 6:30 p.m., Tuesday, Feb. 1, at El Charro Cafe. Sixty persons attended.

In the absence of the chairman and vice-chairman, Treasurer Max Eaton presided. His first announcement was that Program Chairman Ed Sullivan had just called from the airport that the speaker, Guy Parkin, was weathered in at Kansas City, but an alternate program had been prepared after receiving word at noon that such might happen.

K. L. Jones, of the Beech Quality Control Staff, and publicity chairman of the section, presented the speech which he gave at the Ninth Midwest Conference in Dallas last November entitled, "A Coordinated Materials Review and Corrective Action Program," ably assisted by Bill Golden at the slide projector.

WINDSOR On Feb. 10 Dr. Brant Bonner addressed a group of 29 persons, who braved the worst storm of the winter, to attend the meeting at O'Keefe's Brewery. Following the presentation of the address, "Quality Control in the Brewing Industry," the group toured the plant. An informal discussion of the brewing industry, led by Kai Jakobsen, chief brewmaster, took place while the guests partook of a sumptuous lunch provided by the management. Needless to say, everyone present spent a most enjoyable evening.

WINNEBAGO The Winnebago Section held its monthly meeting at Oshkosh on Feb. 7. Speaker for the evening was Gayle McElrath, University of Minnesota. Prof. McElrath is well known for his ability to bridge the gap between the theoretical and the practical in what is for some a rather obscure and difficult field. A training period conducted by Dr. Carl Noble preceded the meeting.

WORCESTER F. C. Schulze, sales engineer of Hunter Spring Co., spoke on "Quality Control of Metal Stamping" at a meeting of the Worcester Section on Feb. 17.

The section has just completed a course on Basic Quality Control Fundamentals. Mr. Charles J. Hudson, quality consultant, Miniature Precision Ball Bearing Co., Keene, N. H., was the instructor. The course covered variation, frequency distribution, process control charts and sampling procedures.

YOUNGSTOWN L. A. Seder, Quality Control Consultant, addressed the Youngstown Section at a dinner meeting in the V.F.W. Hall in Youngstown. He gave a very interesting talk on the "Span Plan." Both the dinner and meeting were well attended.

The Timken Roller Bearing plant at Canton, Ohio was host to the Youngstown Section on Mar. 10. An excellent dinner was served in their cafeteria, followed by a very interesting tour through the steel plant and the Roller Bearing Division. Visitors were shown how Timken makes practical use of quality control techniques throughout their plant. About 65 men made the visit.

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ALLENTOWN-BETHLEHEM "Quality Control at Otis Elevator" will be the topic for Charles Scott who will speak at the May 12 meeting of the Allentown-Bethlehem Section at Hotel Traylor, Allentown, Pa.

BALTIMORE Dr. W. E. Deming will be the featured speaker on Apr. 20 and will present his views on "Random Sampling." This is the third visit of Dr. Deming to the Baltimore Section where his fine presentations have earned him a large following. His wit, as well as his sound logic, are expected to blend together to give an evening that will be well remembered.

CLEVELAND Founders Night will be celebrated at the regular meeting on Friday, May 6. This is taking place in conjunction with the Tenth Anniversary of the Cleveland Section. Twenty-six charter members have been contacted, several of whom are still members of the section. Among charter members who have become prominent in A.S.Q.C. circles is Wade R. Weaver, who is past chairman of the Cleveland Section in addition to having been president of ASQC.

DAYTON On Apr. 21 the Dayton Section will journey to Middletown, Ohio, as guests of the Armco Steel Corp. and will tour their plant. After the plant tour a dinner will be served at which time a representative of Armco will give a talk on the "Origin and History of Armco."

On May 19 the regular monthly meeting will be held at the National Cash Register Co. auditorium. A buffet style meal will be served. The speaker for this meeting will be Dr. Max Astrachan of the U.S.A.F. Inst. of Technology, Wright Patterson AFB, and the title of his subject will be "Operations Research." This will be the last regularly scheduled meeting for the season and will highlight a very successful season for the Dayton Section.

EVANSVILLE-OWENSBORO Regular meeting on Apr. 20 is being turned over to the "special events committee" with special invitations to production managers and supervisors to attend the graduation of section's basic training school. The meeting will be held in Sterling Brewery at Evansville, Ind.

May 17 will be Annual Ladies' Nite, with a dinner-dance and installation of officers at G. E.'s Dar-Nek Club in Owensboro, Ky.

ERIE On May 4 our speaker will be Dr. Fred C. Leone of the Case Institute of Technology. The meeting is scheduled for the Hotel Kenyon dining room. At press time Dr. Leone's topic had not been announced but would be either on "Circular Probability Paper" or "Regression Analysis."

GEORGIA Since April 26 is Southern Memorial Day and a holiday, that meeting has been rescheduled for Tuesday, May 3. Dr. Joseph J. Moder, Jr., of the School of Industrial Engineering, Georgia Institute of Technology, will talk on "Some Results of Graduate Research in Sampling and Data Analysis." The meeting will be held in Room 1833 of the Hurt Bldg. at 7:30 p.m.

HUNTSVILLE On Apr. 21 Prof. David S. Chambers from the University of Tennessee

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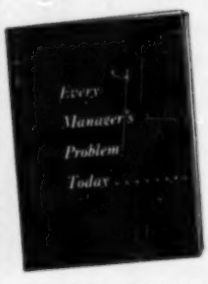

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will speak to the Huntsville Section. The topic of his speech will be "Fundamentals of Statistics."

INDIANAPOLIS The last meeting for the 54-55 season of the Indianapolis Section will be held on May 17 starting at 6:30 p.m. with a dinner. This meeting will be held in the Athenaeum Turner's Bldg., 401 E. Michigan St., Indianapolis. The meeting will honor past presidents of the Indianapolis Section. A Sampling Inspection Skit will be given and a movie of the Indianapolis 500 Mile Auto Race will be shown. Also, at this meeting, the Grand Prize (Tickets to the Indianapolis 500 Mile Race) will be awarded. Members who have attended all of the regular monthly meetings for the past year will have the odds in their favor for winning. It is possible, however, for a member to win with a less perfect attendance, but his chances are also less.

INDIANAPOLIS Columbus Sub-Section On May 12 this sub-section will be addressed by Virgil Alexander, Adams Division of LeTourneau-Westinghouse Co., Indianapolis. His subject will be "Foreman's Responsibility to Quality Control."

INDIANAPOLIS Lafayette Sub-Section On Apr. 27 at 7:30 p.m., the Lafayette sub-section will be addressed by W. C. Vissing, Eli Lilly Co., Indianapolis. His subject will be "Quality Control in a Pharmaceutical Organization."

KANSAS CITY The May meeting of the Kansas City Section will be a dinner meeting at the Blue Hills Restaurant on Wednesday, May 11, at 7:00 p.m. Leon Bass, General Electric's Jet Engine Dept., will be the speaker of the evening. His subject will be "Vendor Certification."

MICHIGAN "What Is Your Problem, Friend?" That is the topic for the panel assembled to discuss the various problems encountered by the section members relative to all phases of SQC operations. The meeting will be on May 13 at the Science Hall of Wayne University, Detroit. Panel members will be H. S. Bayer, QC Consultant; T. DiGaetano, Parke, Davis & Co.; T. A. Halmi, Houdaille-Hershey Corp.; P. Roche, Detroit Arsenal; J. Randall, Chevrolet; Dr. E. C. Yehle, University of Michigan.

MILWAUKEE Our May 9 meeting will be a dinner meeting and our featured speaker is to be Leo J. Jacobson, International Resistance Co., Philadelphia, Pa. His subject will be "Process Capability Considerations in Product and Process Design."

MINNESOTA On Thursday, May 12, the Minnesota Section will hold a combination business meeting and social evening which is scheduled to be held at the Jacob Schmidt Brewing Co. in St. Paul.

MONTREAL The guest speaker at the Apr. 29 meeting of the Montreal Section will be M. K. Kiuger, Bell Telephone Laboratories, New York. The meeting will be held at McGill University, starting time 8:15 p.m.

On May 11 the section will be the guests of Dominion Rubber Co., Ltd., Montreal. Dominion Rubber has been actively engaged in statistical quality control for many years and has control charts on all its operations. The plant tour should afford a good opportunity for anyone interested in SQC to see how a full scale SQC system operates.

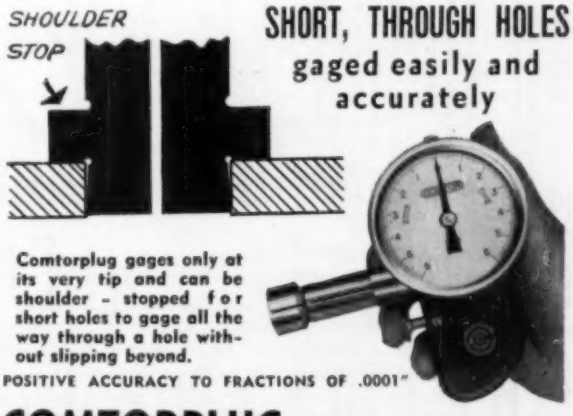
MUNCIE G. B. Baumeister, Engineer Special Products Dept. of Magnaflux Corp., Chicago, will speak at the Apr. 21 meeting of the section on the subject "New Horizons—Non-destructive Testing."

NEW HAVEN On May 10 the final meeting of the 1954-55 season will feature W. R. Purcell, Rath and Strong, Inc., on the subject "Uses of Median and Range Charts." Dinner will be served prior to the meeting.

RICHMOND The Richmond Section will have an opportunity to find out what Operations Research can do for quality control at the supper meeting to be held Tuesday, Apr. 26. Dr. H. O. Davidson of the Operations Research Office, the Johns Hopkins University, is giving a talk on "Operations Research Concepts Useful in Quality Control." Since this is the first time this subject has been discussed at a section meeting here, it should prove of great interest.

At the meeting to be held May 17, George F. White, Jr., Reynolds Metals Co., will give a talk on "Introduction to Statistical Sampling Inspection." This will include some of the basic concepts of sampling and the procedures necessary in setting up sampling plans.

ST. LOUIS Because of the Convention dates, May 23-25, the St. Louis Section has moved



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CALENDAR OF MEETINGS -- APRIL 20, 1955 -- MAY 19, 1955

*Indicates meeting dates in April

SECTION	DATE	MEETING PLACE	TIME	SUBJECT	SPEAKER
Allentown-Bethlehem	12	Hotel Traylor, Allentown, Pa.	———	Quality Control at Otis Elevator	Charles Scott, Otis Elevator
Boston	16	———	———	A New England Businessman Looks at Quality	C. F. Adams, Raytheon Mfg. Co.
Buffalo	25*	University of Buffalo	———	Statistical Applications in the Chemical Industries	W. J. Youden, National Bureau of Stds.
	16	Am. Machine and Foundry Plant	———	Statistical QC Program at A.M.F.	A.M.F. Staff
Cleveland	6	———	———	Founders Night, 10th Aniv. of Cleveland Section	———
Columbus	18	Timken Roller Bearing, Columbus	———	SQC Applications at T R B, Columbus Plant	Plant tour
Dayton	21*	ARMCO Steel, Middletown, Ohio	———	Origin and History of ARMCO	Representative, ARMCO Steel Corp.
	19	NCR, 10th Floor Auditorium	———	Operations Research	Max Astrachan, USAF Inst. of Tech.
Delaware	5	———	———	Auditing Quality of Product	G. R. Page, Western Electric Co.
Evansville-Owensboro	17	Dar-Neck Club, Owensboro	7:30 p.m.	Ladies Night	Dinner-Dance
Erie	4	Hotel Kenyon	———	———	F. C. Leone, Case Inst. of Tech.
Georgia	3	Rm. 1833, Hurt Bldg.	7:30 p.m.	Research in Sampling & Data Analysis	J. J. Moder, Jr., Georgia Inst. of Tech.
Harrisburg	11	American Legion Post 27	———	Annual Meeting	———
Huntsville	21*	———	———	Fundamentals of Statistics	D. S. Chambers, Univ. of Tennessee
Indianapolis	17	Athenaeum Turner's Bldg.	6:30 p.m.	Sampling Inspection Skit and Movie — 500 Mile Race	———
Kansas City	11	Pine Room, Union Station	7:00 p.m.	Vendor Certification	Leon Bass, General Electric Corp.
Lansdale	12	———	———	Annual Meeting	———
Los Angeles	12	———	———	Ratio Delay or Work Sampling	J. R. Crawford, Lockheed Aircraft
Michigan	13	Science Hall, Wayne Univ.	———	What's Your Problem?	Panel
Mid-Hudson	3	Germania Hall	———	Social Night	———
Milwaukee	9	Marquette University	6:00 p.m.	Process Capability Considerations in Product Design	L. J. Jacobson, International Resistance
Minnesota	12	Jacob Schmidt Brewing Co.	———	Business meeting and social evening	———
Montreal	29*	McGill University	8:15 p.m.	———	M. K. Kiuger, Bell Telephone Labs.
	11	Dominion Rubber Co.	———	Plant tour	———
Muncie	21*	———	———	New Horizons — Non-destructive Testing	G. B. Baumeister, Magnaflux Corp.
	19	———	———	Who is Responsible for Quality?	L. A. Seder, QC Consultant
New Haven	10	———	———	Uses of Median and Range Charts	W. R. Purcell, Rath & Strong, Inc.
NE Indiana	5	———	———	Annual All Day Conference	———
Rhode Island	21*	———	———	Ladies Night	———
	19	———	———	Vendor Certification	P. A. Robert, IBM Corp.
Richmond	26*	Holloway House	6:15 p.m.	Operations Research Concepts Useful in QC	H. O. Davidson, Johns Hopkins Univ.
	17	Holloway House	6:15 p.m.	Introduction to Statistical Sampling Inspection	G. F. White, Jr., Reynolds Metals Co.
St. Louis	13	———	8:00 p.m.	Social Evening and Installation of Officers	———
Salt Lake City	5	———	———	Vendors Certification	Leon Bass, General Electric Co.
San Diego	9	San Diego Club	6:15 p.m.	Vendors Certification	Leon Bass, General Electric Co.
Scranton-Wilkes-Barre	20*	———	———	———	J. M. Juran, Management Consultant
Seattle	10	———	———	Problems in Training for Quality Control	Joint meeting with ASTD
South Bend-Mishawaka	21*	Notre Dame University	7:30 p.m.	Ford Motor Company films on vendor certification	Andy Thomas, Bendix Products, Narrator
	19	———	———	Annual Dinner Meeting	———
Southern Connecticut	18	Stratfield Hotel, Bridgeport	———	The Pursuit of Facts	Dorian Shainin, Rath & Strong, Inc.
Southern Tier	3	Vestal Am. Legion Clubhouse	———	Quality Control in the Office	W. F. Buhel, B. F. Goodrich Co.
State Univ. of Iowa	21*	Rock Island, Ill.	———	———	Robert Storer, Ordnance Ammunition Command
	19	———	———	Annual dinner and social evening	———
Syracuse	26*	———	———	Quality Control Applications in the Accounting Area	John Neter, Syracuse University
	17	———	———	Management in Quality Control	A. M. Koerner, Eastman Kodak Co.
Toledo	———	Devil's Lake, Mich.	———	Stag social	Host; A. B. McGehee, M & S Mfg. Co.
Toronto	20*	Oakville, Ontario	8:00 p.m.	Plant visit	Canadian General Electric
	4	University of Toronto	8:00 p.m.	Quality Control in the R.C.A.F.	Wing Commander Regan, R.C.A.F.
Trenton	6	Glendale Tavern	———	Responsibility of American Citizenship	J. G. Gill, Rider College
Washington	27	Nat'l Canners Assoc. Bldg.	8:00 p.m.	Relation of QC to Engineering Standards and Tolerances	E. E. Schiesel, Mattatuck Mfg. Co.
Wichita	3	———	———	Johns-Manville film	S. Collier, Johns-Manville
Winnebago	2	Fond du Lac, Wis.	———	General Air Force Policies and Procedures	Speaker from USAF
Worcester	21*	———	———	Ladies Night	———
	19	———	———	QC: its Implications and Potentialities	A. Strong, Rath & Strong, Inc.
Youngstown	10	G.E.'s Nela Park	———	Ladies Night	———

their regular meeting date forward one week to May 13 which will be their Social Evening of the year. All of the wives are invited to attend for a quality control talk which we hope all wives will understand and, of course, a "social mixer" will follow this meeting.

SALT LAKE CITY On May 5 Leon Bass, Jet Engine Dept. of General Electric, will address a dinner meeting of this section on "Vendor Certification."

SCRANTON-WILKES-BARRE A Panel Discussion will be the main event of the Wednesday, Apr. 20 meeting at the Scranton YMCA. At the May 18 meeting J. M. Juran will discuss various aspects of Quality Control. This meeting will also be held at the Scranton YMCA.

SEATTLE On May 10 we will have a joint meeting with American Society of Training Directors. Subject: "Problems in Training for Quality Control." Moderator, Charles Broaded, Director of Personnel, Fisher Flouring Mills, Seattle. Speakers: Berl Owens, dept. of mechanical engineering, University of Washington; M. J. Boston, supt. manufacturing training, Boeing Airplane Co.; R. A. Frost, instructor of industrial psychology, University of Washington.

SOUTH BEND-MISHAWAKA The Ford Motor Co. films on vendor certification will be presented and narrated by Andy Thomas of Bendix Products at the Apr. 21 meeting. The meeting will be at 7:30 p.m. in the Engineering Auditorium of Notre Dame University.

SOUTHERN CONNECTICUT The Southern Connecticut Section will present Allin P. Deacon, quality control consultant, on Apr. 13 in the Stratfield Hotel, Bridgeport. Until recently the speaker was connected with the Cockshutt Farm Equipment Co., Brantford, Ontario, as supervisor of foundry quality control. The subject for his talk will be "Foundry Quality Control for Short Runs." Deacon has specialized in establishing foundry quality control systems in Canadian industry. His experiences with the successful quality control operations at the Cockshutt Farm Equipment Co., as well as other functionally tried results concerning foundry quality control methods, is expected to prove of timely interest to the many Connecticut area Society members who are engaged in foundry casting of basis products.

To add to the general interest of each meeting a series of short films have been arranged. The April meeting will feature the first two such films which are in the electronic and automotive fields.

SOUTHERN TIER The Southern Tier Section will hold its monthly dinner meeting on May 3 at the Vestal American Legion Clubhouse. William F. Buhel, senior procedure analyst in the Office Procedures and Methods Department, B. F. Goodrich Co., Akron, will be the guest speaker. Mr. Buhel will present "Quality Control in the Office."

STATE UNIVERSITY OF IOWA Robert Storer of the Ordnance Ammunition Command, Joliet, Ill., will be the speaker at the Apr. 21 meeting of the Quint-City group at the Iowa-Illinois Gas and Electric Co. Auditorium at Rock Island.

The annual dinner meeting of this group will be held on May 19 at which time officers will be elected for the coming year. The ladies are being invited to this meeting which will also be a social evening.

SYRACUSE John Neter, assistant professor of business statistics, Syracuse University, will discuss "Quality Control Applications in the Accounting Area" at the section meeting of Apr. 26.

TOLEDO Our May meeting is being planned as an all day stag social at one of Southern Michigan's very inviting lakes. This is very probably our best attended affair—as it is an annual event. Our new officers for 1954-55 will be announced at this meeting.

TORONTO On Apr. 20 at 8:00 p.m. will be a plant visit to the Canadian General Electric plant at Oakville, Ontario.

On May 4 at 8:00 p.m. in the McClennan Laboratory, University of Toronto, Wing Commander Regan of the R.C.A.F. will speak on "Quality Control in the R.C.A.F."

TRENTON Trenton Section will close the season with a dinner meeting at the Glendale Tavern on May 6. Guest speaker will be Mr. J. Goodner Gill, vice president, Rider College. His subject of discussion will be "Responsibility of American Citizenship."

WASHINGTON On Apr. 27 Ervin E. Schiesel, The Mattatuck Mfg. Co., Waterbury, Conn., will speak on "Relation of Quality Control to Engineering Standards and Tolerances." The meeting will be at the National Canners Assoc. Bldg., at 8:00 p.m.

WICHITA Last year one of the most interesting programs presented by the Wichita Section was a panel discussion. Popular demand for the inclusion of another such program in this year's program led to the scheduling of a panel discussion on Materials Review and Corrective Action Procedures. This program was originally scheduled for May 3; however, due to a conflict in schedule, the speaker for the Apr. 5 meeting could not attend on that date, but could arrange to be here May 3. Therefore, the panel discussion with Max Eaton, the section treasurer, acting as moderator, was held on Apr. 5 and S. Collier will present the Johns-Manville film on May 3.

WINNEBAGO The Winnebago Section will hold their May meeting at Fond du Lac, Wis. The speaker for the evening is not yet definite but will be a guest from the U.S.A.F. speaking on "Air Force Policies and Procedures."

YOUNGSTOWN May 10 will be Ladies' Night for Youngstown. An excellent program has been planned for their enjoyment. All ladies will be given a corsage and treated to a fine dinner, following which will be a demonstration at G. E.'s Nela Park in Cleveland.

"AS YE SOW . . ."

AMER. INST. OF INDUSTRIAL ENGINEERS The American Institute of Industrial Engineers will hold its Sixth Annual Convention in St. Louis on May 12, 13 and 14 at the Kingsway Hotel. The conference program this year is one of the best that has been seen in many years. It includes such talks as "Use of Control Charts in Industrial Engineering" by Joseph Movshin, editor of IQC's bibliography department and QC manager of the Ramsey Corp.; "Electronics in Work Measurement" by Prof. Gerald Nadler, Washington University; and "Statistics as a Basis For Management Decision" by E. F. Gibian, Thompson Products, Inc. In addition an extensive program has been planned for the enjoyment of the ladies. Those desiring more information or registration forms for the AIIE Convention can write to C. E. Geisel, 8100 Rockwood, St. Louis 23, Mo.

LOUISVILLE The Second Annual Kentucky Quality Control Clinic will be held Apr. 18, at the Brown Hotel in Louisville, Ky. Program includes exhibitions, speakers, a plant tour of Schenley Distillers, and a banquet.

MILWAUKEE As an educational service to industries in the Wisconsin-Northern Illinois area the Milwaukee Section is offering to show its two navy films "Process Control" and "Acceptance Sampling" to any companies that desire this service. A member of our section goes along with the films to conduct a discussion period after the showing. This service is available at no cost to the company, and is being used on April 28 by the Gerrett Co. of Milwaukee, manufacturers of toy savings banks. Other companies wishing to avail themselves of this service are requested to contact Miss Jean Treuttner, Milwaukee Section ASQC, Box 1204, Milwaukee 1.

PURDUE UNIVERSITY The ninth annual advanced course in "Quality Control by Statistical Methods" will be held June 20-28. This course is intended for those who have already had an elementary course and who wish to go on to more advanced techniques.

The topics will include significance tests and estimation, acceptance sampling by variables, sequential analysis, linear and multiple correlation, analysis of variance, tolerances of mating parts, and the chi-square test. This course is under the direction of Prof. Irving W. Burr and will include on the instructional staff Profs. Mason E. Wescott, Edwin G. Olds, Lloyd A. Knowler, Cecil C. Craig and Charles R. Hicks.

Further information on the course may be obtained from Prof. Burr at Purdue University, Lafayette, Ind.

11TH CHEMICAL INDUSTRY SQC COURSE An eight-day intensive training course in quality control for the chemical industries will be offered by the Rochester Institute of Technology at Rochester, N. Y., June 7-15, 1955. In contrast to courses which usually emphasize mechanical and metal cutting operations, the content of this program is devoted exclusively to the control problems of the chemical and allied process industries.

The course is particularly designed for those responsible for controlling product either in the analytical laboratory or directly in the manufacturing process. Emphasis will be placed on the practical application of quality control in these areas. Instruction will cover basic statistical control and sampling methods as well as many of the advanced techniques such as design of experiments, correlation and analysis of variance. Companies engaged in research and development work, or those having a continuous or batch-lot type of production process will find the program of particular value.

The tuition of $100 per person includes books and supplies. Room accommodations will be available at the Hotel Rochester. Further inquiries should be addressed to the course coordinator, Robert D. Pease, Evening Division, Rochester Institute of Technology, Rochester, N. Y.

UNIVERSITY OF CALIFORNIA Plans for an Institute on Operations Research for Business and Industry to be held Apr. 28 and 29 on the Los Angeles campus of the University of California, have been completed by the University's Division of Engineering Extension.

Defining "operations research" as the application of scientific methods to the solution of management problems, L. M. K. Boelter, Dean of Engineering at the University, points out that the conference is designed for executives of business and industry and will be valuable to all line and staff personnel involved in management decisions. Technical presentations will be minimized in order to emphasize the actual applications and their value to management and the company.

Persons interested in attending the conference are invited to direct inquiries to the Engineering Extension Office, 3116 Engineering Bldg., University of California, Los Angeles 24.

This year's summer course at the Statistical Laboratory of the University of California, Berkeley, Calif., consists of two sessions: June 20-July 30 and Aug. 1-Sept. 10, 1955. The faculty of the summer sessions will include Prof. G. E. Bates of Mt. Holyoke College, South Hadley, Mass.; Prof. J. Neyman, Prof. Charles H. Kraft and Mr. Howard G. Tucker of the Statistical Laboratory, University of California.

The program includes undergraduate courses primarily meant for students transferring from other centers who would like to embark on advanced studies in Berkeley during the regular academic year. Prof. Neyman will be available for consultations on work leading to higher degrees. There will be no graduate course program. However, graduate students may be interested in a series of lectures and seminars to be given through July and August in connection with the second part of the Third Berkeley Symposium on Mathematical Statistics and Probability.

UNIVERSITY OF FLORIDA The University of Florida, North Carolina State College, Virginia Polytechnic Institute and the Southern Regional Education Board are jointly sponsoring a series of cooperative summer sessions in statistics.

The first of these cooperative graduate summer sessions was held during the summer of 1954 at Virginia Polytechnic Institute. The second session will be held at the University of Florida from June 20 to July 29, 1955. The following sessions are scheduled to be held at North Carolina State College in 1956, and at Virginia Polytechnic Institute in 1957.

Each of the summer sessions will last six weeks and each course will carry approximately three semester hours of graduate credit. The program may be entered at any session, and consecutive courses will follow in

successive summers. The summer work in statistics may be applied as residence credit at any one of the cooperating institutions, as well as certain other institutions, in partial fulfillment of the requirements for a master's degree. The catalog requirements for the degree must be met at the degree-granting institutions from which he desires to obtain the degree regarding the applicability of the summer courses in statistics.

The faculty for the 1955 session at the University of Florida will include: Prof. R. L. Anderson, North Carolina State College; Prof. Glenn L. Burrows, Statistical Consultant, Off. of Adm., A.M.S., U.S.D.A. and member of the U.S.D.A. Graduate School faculty; Prof. D. B. Duncan, University of Florida; Prof. Boyd Harshbarger, Virginia Polytechnic Institute; Prof. Carl E. Marshall, Oklahoma A. and M. College; Prof. Herbert A. Meyer, University of Florida; Prof. George E. Nicholson, Jr., University of North Carolina; Prof. Phillip J. Rulon, Harvard University; Prof. Walter L. Smith, University of North Carolina; and Prof. Dudley E. South, University of Florida.

Courses to be offered this summer are: Statistical Methods I, Statistical Methods II (Design of Experiments), Statistical Theory I, Statistical Theory II (Inference and Least Squares), Advanced Analysis I, Theory of Sampling, Theory of Statistical Inference, Mathematics for Statistics, Statistical Research in Education and Psychology, and Seminar on Recent Advances in Statistics.

The total tuition fee will be $35 for the six-week term. The holder of a doctorate degree, upon acceptance, may register without the payment of any tuition fee. Living and other expenses at the University are reasonable.

Inquiries should be addressed to Prof. Herbert A. Meyer, Statistical Laboratory, University of Florida, Gainesville, Fla.

WASHINGTON UNIVERSITY A Motion and Time Study Intensive Course, offered by the Department of Industrial Engineering of Washington University at St. Louis, will be presented from June 8-17. This course is intended for personnel desiring a basic introduction to Motion and Time Study. Material covered will be presented with emphasis on setting up correct methods before work is in existence, as well as on techniques for the improvement of existing methods and procedures. The objectives of the course will be to prepare the attendee to (1) apply Motion and Time Study in his own organization and (2) train others in his company in the principles of Motion and Time Study.

Several visiting speakers will present their experiences with the application of Motion & Time Study and with related fields in industry to further enhance the material of the course. The course is under the direction of Dr. Gerald Nadler of the Department of Industrial Engineering. Other members of the teaching staff will include industrial personnel as well as University faculty.

This course is being presented with the cooperation of the St. Louis Chapters of the American Institute of Industrial Engineers and the Society for Advancement of Management. For further information concerning course content, instructors, and registration, write to the Department of Industrial Engineering, Washington University, St. Louis 5.

DIVISIONS

Textile Division

The Textile Division held its fifth annual conference at Clemson, South Carolina, January 27, 28 and 29. About 210 persons attended the conference, which was very well planned and very well received. The credit goes to Bob Carson, the General Program Chairman, and to his associates.

At the Textile Division Council meeting held January 28, it was announced that the present membership of the Division was 337. Bill Newall's Committee is continuing to work on ways and means to finance a 30 minute sound film in color on textile quality control.

Ed Rudnick's committee reported good progress on their project to create a 20 minute slide film with sound track. This film is aimed at promoting "Quality Consciousness" of employees of staple fibre textile mills, and Ed hopes to be able to show it at the New York Convention.

It was decided to hold the sixth Annual Textile Quality Control Conference at I.T.T. in Charlottesville, and the seventh Conference in Atlanta, possibly at Georgia Tech. Bob Jones was appointed by the Council to handle the Divisions contributions to the program of the Ninth New England Conference. The Council also decided to channel all inquiries for jobs (both from employers and employees) through Vice Chairman Ed Rudnick. This is the first step in formulating a permanent job referral service for our members.

Chemical Division

The total paid up membership in the Chemical Division as of Feb. 1 was 330 members. We have begun work to print and circulate a Chemical Division Directory of members' names and addresses. We also hope to include in the directory supplemental information, such as the number of members in each section. We hope to have this directory available for distribution sometime before May 1.

The education sub-committee has been jointly evaluating with the TAPPI statistics committee, the short courses sponsored by TAPPI in 1952, 53 and 54. This has led to discussion of the desirability of (1) greater emphasis to management aspects of statistical quality control in any educational program and (2) a short course on statics in chemistry. Other planned activities include:

1. Stimulating the development of in-plant statistical courses and evaluating what is presently being done.
2. Stimulating "Statistics in Chemistry" courses in colleges (long term project).
3. Stimulating other professional societies to form statistics programing committees.

The foods sub-committee in cooperation with Dr. Amihud Kramer, University of Maryland, is preparing a bibliography on food quality control. Since Dr. Kramer has been in Israel, the project has been somewhat reduced in tempo. However, work on the bibliography is proceeding and further progress will be reported in the *Chemical Division News*. Dr. Luis de Alcuaz has accepted the position of vice-chairman of the foods sub-committee to direct and coordinate its work in the west.

A. L. Stoeffen has had to resign as the mid-west district counselor. In accordance with the by-laws Otto

Kral, Minnesota Mining and Mfg. Co., St. Paul, was elected by the division council to fill the unexpired term.

Automotive Technical Committee

The Automotive Technical Committee is taking steps to fulfill the requirements to become a division of the Society. This division will encompass the field of self-propelled vehicles and machines, which includes the passenger car, truck, bus, tractor, earth-moving equipment, and the suppliers to these industries.

Members of the Society who are interested in the formation of and membership in the Automotive Division should contact:

Mr. Brent C. Jacob, Jr.
Chrysler Division
12200 East Jefferson
Detroit 14, Mich.

Mr. Jacob is secretary of the Automotive Technical Committee. The other officers are: Chairman John S. Randall, Chevrolet Central Office, Detroit, Mich. and Vice-Chairman J. Clayton Knapp, Ford Motor of Canada, Windsor, Ont.

MEMBERSHIP CORNER

At this time most of the activities of the Membership Committee have been completed for the year. Any intelligent action should have been taken long before this. However, as a final attempt to garner the members who haven't renewed, it is suggested that a repeat personal contact to those members be made.

For those who continually attend meetings but don't sign up a method which might be used would be to remind them that for $5.00 they can become happier members. However, we do recommend that if they do wish to become a member, it is preferable that they pay $15.00 which will carry them over until July 1, 1956.

It is also well to do some sober thinking as to the effects of the year's program so that the present Membership Committee can intelligently recommend improved procedures to the committee which will take office in July.

SIGNIFICANT DIFFERENCES

Norman R. Garner who was vice-chairman of the Huntsville Section and assistant chief industrial statistician at Thiokol Chemical Corp., accepted a new position as consulting statistician to the Surveillance Branch, Naval Powder Factory, Indian Head, Md.

— — — — —

William E. Spencer, past president of the Indianapolis Section, left the Allison Div., GMC, on Mar. 1, to go with Ball Brothers Co., at Muncie as the quality manager of the Glass Div.

— — — — —

Robert Herman of the Milwaukee Section recently left the A. O. Smith Corp. to go into business as a consultant.

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On Feb. 14 the Falstaff Brewing Corp. was host to a group of ten Danish Quality Control experts who were visiting this country under the auspices of the Foreign Operations Administration. Paul K. Leatherman of the St. Louis Section and Director of Falstaff's Quality Control acted as their guide for their visit in St. Louis. All companies who participated in the "Forms Forum" at the Feb. 18 meeting have agreed to submit copies of all forms discussed to the Danish Study Group for their use in Denmark. These forms were requested by members of the group in view of the fact that they were unable to be present for the Feb. 18 meeting.

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A. Henry Morgan, a member of the executive committee of the Southern Connecticut Section, has recently opened his own office in Norwalk, Conn., as an industrial consultant.

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The section development committee of the Southern Connecticut Section under the chairman, E. W. Demeres, has completed and will publish a special project in the form of a 4-page, cartoon-type program brochure which is designed to attract ultimate membership where we presently have no representation. Accompanying the brochure will be a personally directed letter, a copy of the section's yearly program (wallet type, easily referable), and a membership application blank. It is thought that perhaps other sections in the Society may find a new brochure interesting and adaptable to their own use. Sections desiring a sample copy should write to Samual A. Oliva, Dictaphone Corp., 375 Howard Ave., Bridgeport 1, Conn.

— — — — —

Henry E. Stevens, former chairman of the Southern Tier Section and chairman of the section's education committee, has accepted a responsible position in quality control with the American Viscose Corp. at Fredericksburg, Va. Members of the section regret Mr. Stevens' departure but they wish to offer their thanks for his services to the section and extend their best wishes for success in his new assignment.

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The Toledo Section reports that Robert Fox of the National Carbon Co., Fremont, Ohio, was recently promoted and transferred to Iowa by his company. Also Paul Plessner, formerly of the Ransom and Randolph Co., Toledo, has taken the position of chief engineer for the Woodville Lime and Stone Co., Woodville, Ohio.

— — — — —

Lawrence Mueller, who for the past years has been the education chairman of the Western Massachusetts Section has severed his connection with Bigelow-Sanford Carpet Co., Thompsonville, Conn., and is now located with the Dixiana Rug Co. The entire section wishes Larry the best of luck in his new venture.

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Francis Olson, chairman of Worcester Section's membership committee, keeps track of guests by sending out the names of any new persons attending each meeting to the area chairman involved. The area chairman's job is to contact these people personally or by phone to keep up continued interest.

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Wharton F. Keppler, formerly statistician at the USN Ordnance Test Station in Inyokern, Calif., has recently transferred to Eglin AFB, Fla., where he is an operations analyst with the Air Proving Ground Command.

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The Chemical Division notes with regret the recent passing of one of its members, Arthur Grundmann of the Delaware Section.

provided with the lower cross-head position, the maximum distance is 50 inches. Frames for maximum loads other than standard or for compression testing can be provided. It is recommended that a Marshall creep furnace operating to temperatures of 1,800° F. or 2,400° F. with an inside diameter of 1.5 in. be used with this apparatus. Recording of indicating potentiometer controls for the furnace can be supplied and Gaertner microscopes with internal illumination and carrier-type mountings are recommended where such equipment is needed. All instrumentation is custom designed for each installation.

* * *

The DoAll Company, 254 N. Laurel Ave., Des Plaines, Ill., has added square gage blocks to its already extensive line of gaging equipment. Along with this addition they have developed a new system of square gage block accessories designed to extend the use of square gage blocks in everyday inspection tasks. The new system of accessories can be used with all standard square blocks. Tie rods for assembling stacks of blocks interlock at ¼-inch increments by means of ratchet teeth milled on the rods. A rod of desired dimension is obtained simply by laying one rod against the other to mate the ratchet at the desired point. For secure mounting of vertical gages, DoAll provides a base block (2½ inches square) with two mounting holes in opposite corners to permit anchoring of two assemblies. Surface area is large enough to accommodate as many as four gage assemblies which can be wrung to its surface. Flat caliper jaws with

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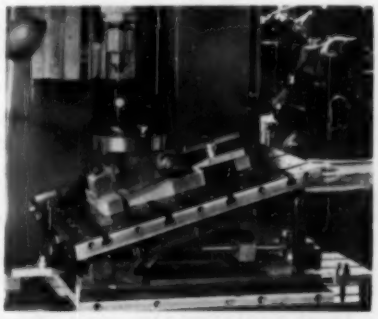
George R. Foster, Mng. Ed.
Room 6123 Plankinton Bldg.
161 W. Wisconsin Ave.
Milwaukee 3, Wis.

1" and 3" extensions permit checks of outside diameters up to 5⅞ inches. For checking inside diameters, round caliper pins are available in diameters of 0.100 inches and 0.200 inches. These are held with special Vee blocks. Scriber and center points are also part of the accessory system. Special drilled and tapped blocks accommodate brackets for holding dial indicators in several positions, depending on the nature of the gaging task. The special gage blocks provide a fast method for precalibrating a dial indicator before it is assembled into a gage. In conjunction with this announcement of its new square blocks and gaging accessories, DoAll is now offering a complete calibration service for all makes of square gage blocks and accessories. A special rapid service is available whereby a size check and complete calibration can be obtained in 48 hours.

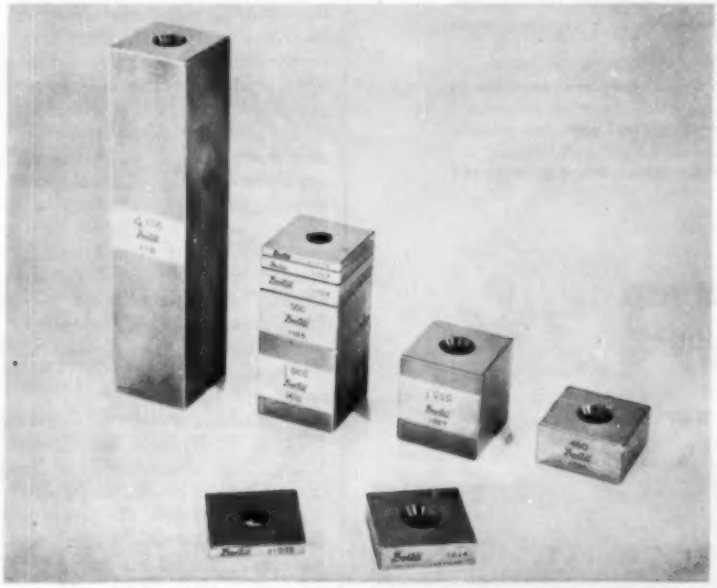
* * *

A new Model 146 Flame Photometer has been announced by the **Perkin-Elmer Corporation**, Norwalk, Conn. The new instrument incorporates several features to permit simple and precise read-out of data, enabling a relatively inexperienced operator to turn out accurate determinations. Data is read out on counters instead of vernier dials. Model 146 makes use of a duo-prism monochromator to provide maximum discrimination between elements and the most rapid selection of the wavelengths of all elements that emit in a gas flame. A highly stable and sensitive electronic amplifier is used. Other features include a burner that may be used on natural or manufactured gas, as well as propane or acetylene, and an atomizer designed for easy cleaning and efficient drain arrangement. The main instrument cabinet removes as a unit, exposing all internal parts for ready servicing. Model 146 may be operated either as a direct reading instrument or as an internal standard ratio instrument. The time required for analysis is less than one minute per element with an accuracy of ±1%. A sample size of two to five cc is sufficient for an analysis. Analyses may be made in solution on sodium, lithium, potassium, magnesium, calcium, strontium, barium, chromium, manganese.

* * *



A new line of large sine plates is available from **Omer E. Robbins Company**, 24800 Plymouth Rd., Detroit, Mich. These single angle, nonmagnetic units measure 24" x 24" and are equipped with mechanical raising and lowering devices for quick, top plate adjustment. Only standard gage blocks are required for fast, accurate setups. Gage blocks are positioned on each of the two gaging pads to eliminate the possibility of distortion. Two sine plates may be used together to produce any compound angle. Top plate and base plate are cast and scraped parallel to 0.0005 inches. Distance between roll centers is 20 inches. Maximum angle setting is 60 degrees.



with

PRATT & WHITNEY AIR-O-LIMIT *Gages*

Engineered by Pratt & Whitney for a leading bearing manufacturer, this special application utilizes an Air-O-Limit Gage with Light Signal Control Unit mounted directly on a centerless grinder used to finish outer bearing races. These races ***must be accurate*** . . . tolerances are held to .0003". As the races are fed from the machine, they are gaged ***continuously and automatically*** . . . providing these important advantages:

- **REDUCED SCRAP LOSS** . . . Rejects used to average 1.5%; have dropped to as low as 0.59% for a full week's production.
- **FASTER PRODUCTION RATE** . . . up to 90 races per minute, without sacrificing accuracy . . . is possible as a result of continuous gaging.
- **LESS NON-PRODUCTIVE TIME** . . . operator can correct machine before parts exceed limits *without* stopping production.

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DIVISION NILES-BEMENT-POND COMPANY
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First Choice for Accuracy

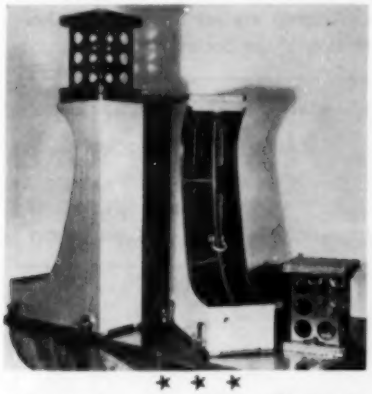
MACHINE TOOLS • CUTTING TOOLS • GAGES

Federal Products Corporation, 1144 Eddy Street, Providence 1, R. I., have introduced a new semi-automatic gage using electronics for 100% inspection of small parts. The gage illustrated, Model 144 B-53, measures the chordal height of the curvature on thermostatic diaphragms and sorts them into six good categories, plus oversize and undersize. The speed of this hand-fed, timer-controlled gage is approximately 2,500 pieces an hour, depending upon the dexterity of the operator. A workpiece is first placed over the retracted reference anvil. The foot pedal is then pressed to start the gaging cycle. A reference anvil moves up to support the workpiece beneath the sensitive gaging contact. This contact, a part of the electronic gage head, measures the chordal height and transmits the size signal to the electronic classifier. The classifier causes the trap door corresponding to the measurement to open and after the reference anvil retracts, the operator slides the part into the correct disposal chute. Only one door is open at a time to prevent mis-sorting. Each disposal unit is equipped with counters to record the inspected production. By using an operator in combination with electronic gaging and electronic classifying, it is possible to get rapid, 100% inspection of mass-produced parts that are not suited to fully automatic inspection.

* * *

The Machine Products Corporation, 6771 E. McNichols Rd., Detroit 12, Mich., has announced a complete line of height blocks and angle plates with heat-treated, alloyed aluminum bodies and hardened steel tops and bottoms. Both the height blocks

and the angle plates can be used singly or in combination to secure a wide range of heights for varied work requirements. Shot pins are provided on the height blocks for stacking. Hardened steel top and bottom plates are used for accuracy and aluminum bodies for lightness. Six standard size angle plates range in height from 24 to 72 inches. Height blocks range from 5 to 20 inches in 5-inch increments. They are parallel to ± .005″ in 12 inches and heights are ± .001″ within size. In addition to the standard sizes available, specials in both height blocks and angle plates can be furnished.



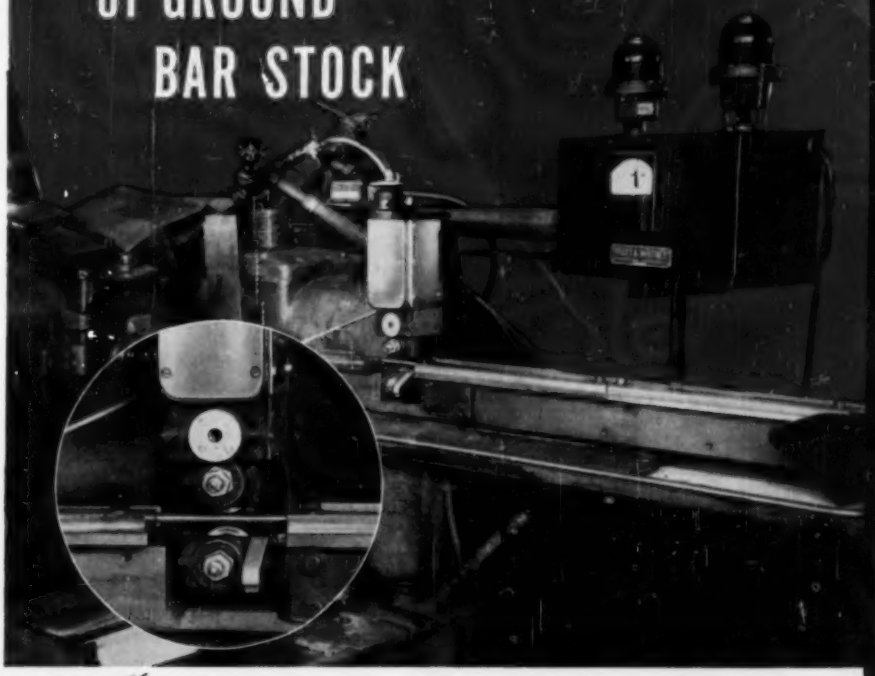
* * *

Syte-Ayde, a device which provides light in out-of-the-way places, is available from **General Scientific Equipment Company,** 2700 W. Huntingdon St., Philadelphia 32, Pa. Powered by flashlight batteries, the Syte-Ayde provides four light transmitting rods. Two are straight, 3½″ and 6″ long and two of the same lengths are bent 90 degrees. Three 1½ power mirrors, ½″, ¾″, and 1¼″ in diameter are supplied with clips which fit rod ends. All parts are contained in separate compartments of a plastic kit. This multipurpose light is used by die makers, pattern makers, tool makers, machinists, trouble shooters, inspectors, engineers, model craftsmen, etc. The kit sells complete for only $5.50.

* * *

Sensory Devices Company, P. O. Box 204, New Vernon, N. J., have introduced the Span Micrometer, a versatile instrument for gear size measurement. It measures spur or helical gears having odd or even numbers of teeth without the need for master gears or accessory pins or balls. Model 1002 measures gears from 32 DP to 2 DP and finer-pitch micrometers are available. Tables for spur gears are furnished with each micrometer and the dimensions for helical gears can be computed from the formulae furnished. To measure a gear the micrometer is opened a little larger than the com-

Continuous ON-MACHINE GAGING of GROUND BAR STOCK



with

PRATT & WHITNEY
Electrolimit Gages

Developed originally for cold rolling mills, the Pratt & Whitney Electrolimit Model D Gage is here applied to continuous, on-machine gaging of precision, centerless ground bar stock. The P&W Light Signal Control with meter used in conjunction with the gage, gives a continuous, accurate reading; light signals indicate oversize or undersize. Important benefits include:

- **BETTER CONTROL OF GRINDING ACCURACY** . . . with immediate correction of machine *before* work is spoiled.
- **FASTER PRODUCTION** . . . operator continuously sees size variations due to wheel wear and makes corrections during grinding.
- **GREATER OPERATOR CONVENIENCE** . . . indicating meter is easy to read; corrections are easier, faster. Extra gaging operations are eliminated.

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puted dimension and the anvils are inserted into the tooth spaces until the anvils touch the root. The micrometer is closed and read. The difference between the micrometer reading and the Span dimension is the amount of base backlash cut into the gear.

★ ★ ★

New Literature

William J. Hacker & Company, Inc., 82 Beaver St., New York 5, N. Y., have available new bulletins covering the Reichert Grain-Size Measuring Eyepiece, the Reichert Micro-Hardness Tester, the Kofler Melting Point Apparatus and Durometers and Control. The bulletins contain information covering the principal features and applications of the equipment.

Brush Electronics Company, 3405 Perkins Avenue, Cleveland 14, Ohio, have available two new bulletins. One details recent developments in oscillographs and amplifiers, while the other lists a series of five related digital instruments for automatic counting, recording and control.

Standard Pressed Steel Company, Box 689, Jenkintown, Pa., has prepared a 32-page, picture-and-text booklet describing its plating facilities and discussing the history and some of the technical aspects of electro-plating. The title of the booklet is "Precision Plating, A Product and A Service."

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This is a Civil Service position with a starting salary of $8360 per annum, unless the person has previously served in the Federal Government at a higher rate and salary. Opportunity for increase in salary exists. Interested parties should complete Standard Form 57, Application for Federal Employment, and return it to the following address:

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Quality Control Engineer desires manager's or assistant manager's position. Four years experience as supervisor, controlling packaging equipment by statistical QC methods. B.S. degree, pre-engineering and majored in statistics for QC. Please reply to Box 11K3 at the above address.

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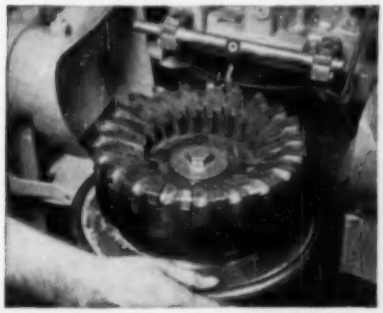

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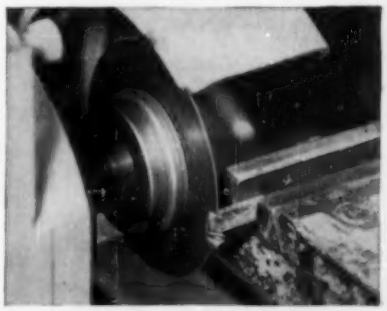

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